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The "Canals" and "Seas" of Mars.

By E. WALTER MAUNDER.

ONCE in two years Mars returns to opposition, and, with that return, the controversy as to the nature of the dark markings upon its surface breaks out afresh.

That controversy has passed through two phases. The first phase was as to whether Professor Schiaparelli had or had not been under some illusion when he represented the planet as crossed in different directions by a number of straight lines, to which he gave the name of "canali"—"channels"—unfortunately rendered into English as "canals." That phase has long been over. There is no doubt now, nor has there been for many years, that Schiaparelli's discovery was a real one; the planet under certain conditions of time and season did really show such markings as Schiaparelli had described, and in the positions where he had located them—did show them, that is, to observers of sufficient training and experience when using telescopes of a certain order of power and under good atmospheric definition.

The controversy for several years past has, therefore, been restricted to its second phase. The "canals" are really to be seen on Mars under the appropriate conditions, but what is their nature? What do these hard, narrow, straight lines really indicate?

All the world knows that one astronomer, whose name is only less intimately connected with that of the red planet than is that of Schiaparelli himself, Professor Lowell, of Flagstaff, Arizona, has insisted for many years past that these "channels" are veritable "canals," the work of intelligent operators, and that they are, therefore, proofs that Mars is inhabited by a race of beings more skilful, more able, more intelligent than ourselves. Every other year, therefore, we have notes and articles in magazines and newspapers on the conditions of intelligent life in Mars, on the possibility of the inhabitants of that planet communicating with us, or of our communicating with them, and much of the same sort; and every other year scientific men are called upon to decide whether they will "fool" the man in the street "to the top of his bent" or slay anew a fable that they have so often slain before.

Why should the fact that, under certain conditions, Mars appears to be covered by a spider's web of narrow, straight lines be supposed to be evidence of such a tremendous engineering activity on Mars? The activity is tremendous, indeed, for the total length of the canal system as now shown by Professor Lowell is between 700,000 and 800,000 miles, upon a planet that possesses not much more than one-fourth the surface area of our earth. On the assumption of 15 miles as the average breadth of a canal, one-fifth of the whole surface of the planet has been thus excavated. Even if, with Professor Lowell, to get rid of the incredibility of artificial excavations far greater than the Red Sea, the Gulf of California, or the Adriatic, we suppose that the "canals" as we see them are not the actual waterways themselves, but merely the long, narrow strips of cultivated land which they irrigate, the supposed demand on the powers of the Martians is, indeed, heavy. Our little canals at Suez, at Kiel, and elsewhere are the mere trenches of children digging on the sands in comparison.

But what reason have we for supposing that the "canals" on Mars are any less natural than our own lakes and rivers? Just this. Professor Lowell assures us that as he sees them they are perfectly regular; a system of geometrical straight lines intersecting each other and often marked at their intersections by dark dots as perfectly geometrical in their circularity.

There is, however, as I showed in "KNOWLEDGE" nearly sixteen years ago, a far simpler explanation of this seemingly artificial regularity. It is simply that we are not near enough to the planet, or our telescopes are not powerful enough, to show the irregularities. There is a limit of size below which a given object cannot be properly defined by ordinary normal sight; there is a much smaller limit below which it cannot be perceived. But there is a wide range between the two, and within this range an object will be perceived more or less plainly, but its details cannot be perceived. Within this range objects can only be seen separately under the two simplest geometrical forms, *i.e.*, as straight lines or as circular dots.

Professor Lowell regards the straightness of the "canals" and the circularity of the "oases," to use the name which he gives to the dots on Mars, as proofs of intelligent design; they show "economy of labour." The economy of labour is, however, merely in the eye of the observer.

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A simple illustration will show the principle at work. A telegraph wire of unlimited length can be perceived against the background of a bright cloud when it is so far distant that its breadth only subtends a second of arc. But if a short black line be drawn on a white card then the shorter the line the broader it must be for it to be perceived, until, if the length be reduced to 34 seconds or thereabouts, the breadth must be increased to that limit. But this limit, like the limit of one second for the telegraph wire, is a limit for perception; not for fully defined vision. To see as separate objects two equal circular spots, the centres of which are two diameters apart, each spot must be more than a minute in diameter; very nearly 70 seconds, in fact. The range, therefore, from mere perception of a straight line to full definition of irregularities in it is a wide one, and within that range, given a sufficient scattering of the individual objects, straight lines and dots will be the only forms recognised.

The geometrical network first discovered by Professor Schiaparelli, and extended so much by Professor Lowell, simply owes its peculiarity to the integration by the eye of markings too minute to be separately defined; the regularity which appears so evidently artificial to the latter is due only to the irregularities being too minute to be recognised by him.

One circumstance was sufficient to prove this before ever a sufficient resolving power was applied to the "canals" to show their true structure. From time to time "canals" apparently straight when seen near the centre of the planet's disc were seen also as apparently straight when seen near its limb. There could be but one explanation of this regarded as a genuine observation. The "canal" in both cases was formed through the eye joining up two small markings, and the line thus drawn by the eye appeared necessarily straight in all positions, whereas an actual line on the surface of the planet must have appeared curved in some positions, if not in all.

Of late years there has been a steady progress in our knowledge of Mars, and in the efficiency and resolving power of the telescopes applied to it, and as M. Antoniadi has recently shown in the Journal of the British Astronomical Association, Vol. XX., No. 3, the giant refractors, when used by experienced observers, reveal the canals as actually resolved or as showing signs of resolution. "The geometrical network . . . vanished when the planet was practically at its closest approach to the earth, high above the horizon, and scrutinised with the best instruments of our time. And the fact that *no straight lines could be held steadily when much more delicate detail was continually visible* constitutes a fatal objection to their crumbling existence." This conclusion of an observer so skilled and so experienced as M. Antoniadi, as the result of his study of the planet with the Meudon 33-inch refractor, one of the finest and most powerful in existence, is decisive. The regularity and artificial appearance of the "canal" system is gone, and with it the only excuse there ever was for considering it a proof of intelligent engineering on our neighbour planet.

Yet one other word is necessary. Professor Schiaparelli's work has stood the test of the great increase of telescopic power that is now being applied to the planet. M. Antoniadi's concluding words are most significant: "Wherever the distinguished Italian astronomer had drawn a streak there *was* a group of irregular shading on the surface of Mars." Schiaparelli had not been the victim of an illusion, or of imaginary markings; he had recorded truthfully what he had seen, and as he had seen it; he had seen truly and well up to the limit of the telescope at his disposal.

But how are we now to look upon the "canals" and "seas" of Mars under the new light now afforded to us? What are we to think of the condition of the planet?

There are some facts about Mars which are not in dispute, and we may here put them down in tabular form, together with the corresponding facts about the moon and Venus, expressing each value in terms of the corresponding value for the earth, which in all cases we take as unity. The atmospheric pressure at the surface is computed on the assumption that the atmosphere of each of the four bodies forms the same fraction of the total mass of the body; an assumption which probably over-estimates the atmosphere of the smaller ones.

	Moon.	Mars.	Venus.
Distance from Sun	1·000	1·524	0·723
Light and heat per unit of surface ..	1·000	0·43	1·91
Length of year	1·000	1·88	0·62
Length of sidereal day	27·52	1·0288	(?)
Diameter	0·272	0·530	0·944
Surface	0·074	0·281	0·891
Volume	0·020	0·152	0·84
Mass	0·013	0·107	0·78
Density	0·63	0 72	0·93
Force of gravity at surface	0·15	0·38	0·87
Atmospheric pressure at surface ..	0·026	0·145	0·764

The following details are given for the earth as well as for the three other bodies:—

	Moon.	Mars.	Venus.	Earth.
Albedo	0·20	0·28	0·90	0·72
Height, in miles, of half surface pressure	22¼	8¾	3⅝	3½
Height, in miles, where pressure = that of Earth's atmosphere	20⅞	15	9½	...
Boiling point of water at surface	22° C.	54° C.	93° C.	100° C.

For my present purpose the two most significant items in the above tables are the differences in the amount of light and heat per unit of surface received by Mars and the earth, and the differences in the range of temperature within which water remains in the liquid form on the two bodies.

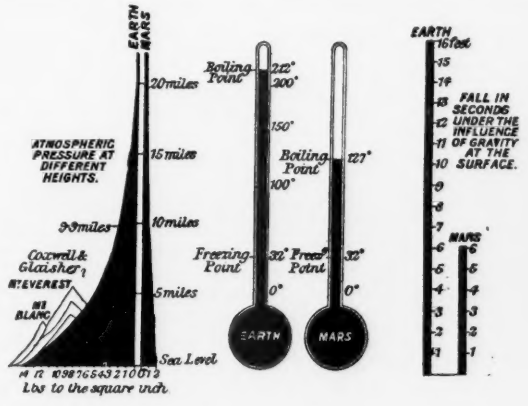
The effect of the first consideration is hard to estimate completely. At the equinoxes a place on the earth's surface situated in lat. 64½° receives per unit of surface about three-sevenths of the heat received at the equator, and the mean temperatures corresponding to the two places will be about 0° C. and 29° C. respectively. Since the unit of surface on the equator of Mars receives about three-sevenths of the heat received at the earth's equator we may put the mean temperature of the Martian equator as 0° C., and the mean temperature of the planet as considerably below this. The mean temperature of the earth is put as 15° C., in other words, as 14° below that of the equator, so that from this point of view we should have −14° C. as the mean temperature of Mars.

Many circumstances would tend to modify this estimate, but chiefly in one direction, viz., to lower it. The atmospheric and oceanic circulations of the earth tend to equalise temperatures; the mean temperature of the equator is lower, that of lat. 64½° is higher, than either would be but for such moderating influences. But the feeble force of gravity on Mars means that the atmospheric circulation is feeble also and there are no

great oceanic areas, so that a like moderating influence is less effective there. It is probably not an extravagant estimate if we put the mean temperature of the whole planet as about −15° or −18° C., and the mean temperature of its equatorial regions as about 0° C.

This means that the mean *day* temperature of the equatorial regions is well above 0° C. The daily range of temperature on Mars must be far greater than anything we experience here; the clearness with which we see the surface of the planet shows that very little light is absorbed or scattered by the atmosphere; the low albedo shows that the reflective power of the soil is small, and that, in consequence, the factor of absorption during the day and radiation during the night is high. It is not at all improbable that the maximum *day* temperature of the Martian tropics is as high as that of our own tropics, but that the rise above freezing point during the day is compensated for by an equal fall below it during the night.

How does this agree with what we see of the planet? Admirably well, for it must be remembered that we only see the side in daylight, and of that side we see best the tropics, and such of the sub-tropical regions as are enjoying summer. We see best, therefore, the hottest



regions of the planet, and are too apt to forget that there are other regions not so well off.

If from the equator we turn our attention to the poles we find that each pole in turn is subjected *continuously* to the solar rays for a period nearly equal to an entire year of the earth; the northern pole is so exposed for more than a year. Consider from this point of view the very small range of temperature through which water will remain in the liquid state upon Mars—54° C. as contrasted with 100° C. here.

On the earth the mean temperature for practically all places outside the polar regions is above freezing point, and nowhere does even the extreme temperature approach boiling point. Therefore the normal condition of water upon the earth is the liquid form. On Mars the mean temperature is below freezing point, and, therefore, the normal condition of water is that of ice or snow, whilst the range of temperature through which, if once melted, it can remain in the liquid state is so comparatively small, that it is not at all impossible that at times during the long polar summer it may positively boil away.

That the polar caps diminish with a speed and to a degree utterly in excess of anything that takes place with the corresponding terrestrial caps is well known; the explanation lies partly in the length of the Martian summer, partly in the small amount of moisture on the planet, and, therefore, in the thinness of the polar deposit, but chiefly in the readiness with which the snow, once melted, would pass into vapour and be carried towards the equator.

The above considerations do not appear to render it likely that there is any vegetation upon Mars. A planet, ice-bound every night, and with its mean temperature considerably below freezing point, does not seem promising for vegetation. Yet it would be too much to say that some hardy forms of a low type may not exist, and it is clear that at a distance of forty millions of miles away it will not be easy for us to discriminate between the darkness of sheets of water and the darkness of stretches of vegetation.

Some, therefore, of the so-called "seas" may be wholly or partly stretches of vegetation, and not entirely water expanses. But that some of the "seas" really deserve the name is clear. If there are no water surfaces, there is no evaporation; if there is no evaporation, from whence can the supply of moisture come to build up the winter pole-cap?

It was one of the many oversights in the theory which regarded the "canals" as artificially made waterways that no source for the moisture supposed to be locked up in the winter pole-cap was ever indicated. Professor Lowell held that there were no large bodies of water on the planet; the so-called "seas" were

cultivated lands. Hence there was little or no evaporation and no means whereby the polar deposits could be recruited.

Yet it is certain that from the evaporation of water in some region or other the supply of the winter pole-cap must come. And here lay another oversight of the artificial "canal" theory. The "canals" were supposed to be necessary for the conveyance of water from the pole towards the equator, although this was "up hill," so that vast pumping stations at short intervals had to be predicated, regardless of the small effectiveness of an ordinary pump in so rare an atmosphere. But it was not supposed that the water needed to travel by way of the "canals" to the poles; indeed, there would be something too farcical in the idea of the careful Martians despatching their water first to the pole to be frozen there, and then, after it had been duly frozen and melted again, fetching it back along thousands of miles of "canals," and through numberless pumping stations, for use in irrigating their fields. If, however, the moisture was conveyed in winter to the pole as vapour through the atmosphere, is it quite impossible that it might be so conveyed in summer from the pole? And in that case what need of artificial "canals"?

Yet another oversight was this, that of all the hundreds of "canals" only a few actually touch the

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polar caps. But, on the theory, the entire "canal" system was fed by the polar cap then in summer, and the carrying capacity of the polar "canals" should have been equal to, if not greater than, that of the entire system outside, for they supplied them all.

Leaving this baseless fable on one side, what we know of Mars shows us a planet ice-bound every night, but with a day temperature somewhat above freezing point. As we see it we look on its warmest regions, and the rapidity with which it is cleared of ice, snow, and cloud shows the atmosphere to be rare and the moisture little in amount and readily evaporated. The "seas" are probably shallow depressions filled with ice at night, melted as to their surfaces by day. Probably, from the variety of tints noticed in the "seas" and the recurrent changes in their outlines, water on Mars is found rather in congeries of shallow pools fed by sluggish streams than in great ocean basins into which great rivers discharge themselves. Hence one season may show an area as a "sea," which during another may show as land, and the continual succession during the day and night of freezing, melting, evaporation, condensation, precipitation, and freezing again must involve a good deal of change in the distribution of moisture in a short space of time.

The "canals," then, are the chief streams and channels on the surface of the continents or higher grounds; the "seas" the collections of shallow pools on the lower grounds; and we have little more reason to suppose the existence of animal life, still less of intelligent life, on Mars than on the moon.

The two tables given above strongly suggest that Mars, on the whole, must approximate in its condition to that of the moon, whilst Venus will far more closely resemble the earth. One all-important factor is in doubt in the case of Venus, the length of its rotation-period; if this is about the same length as our own day then no doubt Venus is the true twin-sister of the earth. If the rotation and revolution periods of Venus are the same, then its unlikeness to the earth must be extreme.

THERE appears to be a consensus of opinion among the French scientists that the causes of the recent phenomenal rise of the Seine, when it reached the record height of 31 feet 2 inches, are to be found more in geological than in meteorological conditions. The basin of the Seine and the streams that are tributary to that river consists of a light absorbent soil; and, as the slopes are gentle, any sudden precipitation is ordinarily absorbed by the ground. In winter, when the soil is either frozen or saturated by the rains, there is a risk that the run-off of a heavy precipitation will be so large and sudden as to overtax the capacity of the river channels. These conditions obtained to a marked degree during the recent continuous heavy rainfall and flood. Meunier, the geologist, is of the opinion that the heavy rains preceding the flood found the soil of the Seine watershed so thoroughly impermeable because of saturation, that the water ran off as swiftly as it would from the surface of an asphalted or cemented street.

HITHERTO dew has been used as a beverage only in poetry, by the sun, flowers, and butterflies. It has recently been robbed of all its poetic character by being used for the refreshment of English soldiers. The English administration at Gibraltar, where water is very scarce, now collects dew by the following very simple method. A large pit is dug in the earth and covered with dry wood or straw, which, in turn, is covered either with earth or with sheet iron. The straw or wood serves as a heat insulator, and effectually prevents the conduction of heat from the ground to the layer of earth or the sheet iron above. Consequently this earth or iron cools after sunset much more rapidly than the ground, so that its temperature soon falls below the dew point of the surrounding air. Hence dew is formed upon the iron or the layer of earth in very large quantities.

The Natural History of the Eel Family.

By J. T. CUNNINGHAM, M.A.

IN a previous article in this journal (November, 1909) I discussed recent discoveries concerning the larval form of the common eel and its migrations. A great deal more, however, is required to complete the life-history of this species alone, and then the question naturally arises how far the species of the eel family resemble one another in their habits, reproduction, and development. I propose, therefore, in the present article to consider the natural history of the eel family in general. In the older classifications the eel and its allies were placed in one family, Murænidæ, which was co-extensive with the sub-order Apodes as now defined. This sub-order is sub-divided into a small number of families closey allied to one another, namely, the Anguillidæ, four small families of deep-sea eels allied to the typical forms, and the Murænidæ, which are more remote. The obvious external peculiarities of eels, namely, the elongated slender shape, the absence of the pelvic fins, and the reduction or absence of scales are by no means sufficient to distinguish them from other fishes; members of various other families or sub-orders have assumed by what is called homoplasy the eel-like form of body. Whether this is in all cases due to adaptation it would be rash to decide at present, but, on the whole, it seems reasonable to conclude that the modification is associated with the habit of burrowing or creeping into holes and crevices for protection and concealment. Under the influence of Mendelism there is a tendency among evolutionists at the present time to believe that habit has been determined by structure and not structure by habit, but the present writer cannot accept this view. The Apodes are distinguished by internal characters, some belonging to the skeleton which for the present purpose it is not necessary to describe. Of the others the most interesting are that the ovary is not a closed sac as in most fishes, but a simple band producing eggs on the outer side, and that the air bladder has an open duct communicating with the œsophagus. In both these characters the eels resemble the Salmonidæ. In Apodes, then, there is no oviduct and the eggs pass out by simple abdominal pores. The so-called electric eel is not an eel at all in the proper sense of the word; its ovaries are closed sacs communicating with the exterior by oviducts, and although it has the shape of an eel it has no dorsal fin, while its ventral fin extends from the end of the tail to a point close to the throat where the anus is situated. The scientific name of the electric eel is Gymnotus, and it is the type of a family of South American fresh-water fishes allied to the carps. Another family of fishes with a superficial resemblance to eels is that of the Symbranchidæ, fresh-water fishes of India and the East Indies; these also have enclosed ovaries and oviducts, and their branchial openings are united into a single opening on the ventral surface of the throat.

The two characters mentioned, together with the entire absence of spiny fin-rays, show that the eels are to be included among the more primitive of the fishes known as Teleosteans, that is to say, fishes with bones and ordinary scales as distinguished from such fishes as sturgeons and sharks. Now there can be no doubt that the Teleosteans originated in fresh water, to which some of the primitive families are confined at the present day. The majority of the Apodes, on the other hand, inhabit the sea and some of them live only at

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abyssal depths. Simenchelys, belonging to the Anguillidæ, has been taken at more than a thousand fathoms in the Atlantic, while some of the more modified forms, such as Nemichthys and Saccopharynx, placed in distinct families, occur at depths exceeding two thousand fathoms. We have seen that the common eel when breeding is a deep-sea fish, spawning beyond 500 fathoms, and the species of the genus Anguilla, which occur in various parts of the world, and those of the genus Moringua, which belong to India and the East Indies, are the only Apodes which are found in fresh water. In view of these facts it is difficult to decide whether the common eel is to be regarded as a deep-sea fish which has acquired the habit of ascending into fresh water or as a fresh-water fish which has developed the habit of spawning in the deep sea. If the former is the true interpretation of the facts, then the eel has returned to the habitat from which it was originally derived.

In most fishes, as in other vertebrates, reproduction is an annual process, and the condition of the fish which has shed its eggs or milt, the spent fish as it is popularly termed, is recognised by fishermen and naturalists. But a spent eel has never been seen. As stated in my previous article there is no evidence that they ever return to the rivers after spawning and there is no doubt that they die. The eel is thus an animal which breeds only once in its lifetime. In this respect it resembles the majority of insects and some other animals, and may be compared with plants which flower only once and then die, and which are said to be monocarpic. The conger (*Conger vulgaris*) likewise dies after spawning, and in this case something more is known of the mature animal than in the case of the eel. Long ago in the aquarium of the Zoological Station at Naples it was noticed that conger after feeding voraciously for months or years ultimately refused to feed, remained fasting for some months, and died with distended abdomens. At the Plymouth Laboratory between 1888 and 1891 the present writer made a special study of the behaviour of conger in the aquarium with the following results. The females grew rapidly, and after reaching a length of $4\frac{1}{2}$ to 6 feet ceased to feed; they continued to live for about six months and then died without spawning. In such conger the roes were enormously enlarged, forming about one-fifth of the total weight; in one case the number of eggs was calculated to be nearly 8 millions. The most remarkable fact, however, about conger in this condition was that the body underwent a gradual atrophy and degeneration, the flesh being reduced, the teeth falling out, and the bones becoming soft and gelatinous. It is evident that the reason why the female conger cannot spawn in confinement is that they can only do so in deep water. Judging from the depth of the sea at the places where Leptocephali of the conger were taken, the Danish investigator Johs. Schmidt infers that the species spawns at depths a little less than those at which the common eel sheds its eggs. He took only 32 specimens of the conger larva altogether, and of these the majority were taken within the 1,000 fathom line, and many over depths of a few hundred fathoms. It is thus evident that the conger spawns beyond the 100 fathom line and the pressure at such depths is enormous compared with that in an aquarium. The male conger, however, became ripe and emitted milt in the Plymouth aquarium; it is very much smaller than the adult female, not exceeding 2 ft. 6 ins. in length. Like the female it lives for several months without taking food and gradually becomes emaciated, diseased, and blind. In the common eel the male is also smaller than the female, but there is not so much difference as in the conger, the maximum for the males being about 18 inches, of the females 39 inches. The common eels which are migrating to the sea to spawn and in which the sexual organs are developing, undergo a change of colour, acquiring what is called the nuptial livery—their light parts become silvery and their eyes become larger. In the conger there is little change of colour, but the ripe or nearly ripe males can be distinguished from females of the same size by their larger eyes.

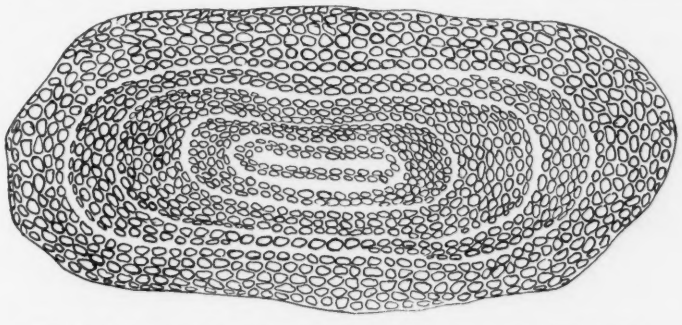

Fig. 1.—Scale of an eel showing five annual zones of growth. After Lunn.

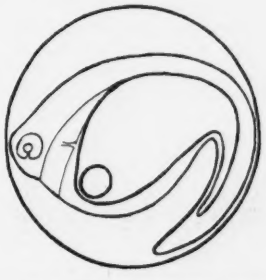

Fig. 2.—Egg attributed to the conger by Eigenmann, under low power of the microscope.

We do not know if other species of the family Anguillidæ also die after spawning, but there is evidence that this is not the case with the Murænidæ. These fishes differ in several points of structure from the typical eels: the pectoral fin as well as the pelvic is absent, the gill apertures are small and round, and the skin is scaleless and coloured with conspicuous regular patterns. During a recent visit to St. Helena, where many species of Apodes occur, I examined a specimen of *Muræna unicolor* which had small shrunken testes containing what appeared to be ripe spermatozoa. The specimen was not quite fresh and the spermatozoa could not be recognised with certainty, but if I was not mistaken the specimen was a spent male, and as it had been caught with bait and its stomach was full of food it was certainly not in a dying condition. Another specimen belonging to the species *Muræna sanctæ helenæ* was a female with eggs nearly ripe, and this also had been caught with bait, while in the conger the eggs do not reach so advanced a stage until the fish has ceased to feed.

Among plants which flower only once in their lives there are some which do not live more than one year and others which live several years like the American aloe. So it is with animals; many insects, for example, run through their whole life-history in a single season. This is not the case with the eels; the common eel is

known to live in fresh water for many years without showing any signs of sexual maturity. In the course of the last few years those engaged in the International Fishery Investigations have shown that it is possible to ascertain approximately with considerable accuracy the age of individual fish in much the same way as we tell the age of a tree by counting the number of annual rings in a section of its trunk. Many of the skeletal structures of fishes, but especially the scales and the calcareous concretions in the auditory organs called the otoliths, show rings of annual growth and by the number of these rings the age can be determined. In the eel the otoliths do not show such rings distinctly, but the eel possesses scales, although they are rudimentary and buried in the skin, and by the rings on these scales the age has been ascertained (Fig. 1). By careful study of the young eels from the time of their first arrival as transparent elvers it was found that they do not develop scales till they are two years old, so that two must be added to the number of rings in the scales to find the number of years an eel has been in fresh water.

We know that the young transparent eels which reach the coast in the spring of the year, February, March, and April, are developed from the Leptocephali which occur at the surface of the ocean in the preceding May and June, so that another year has to be added to the ages given above; but a more obscure question is the connection between these Leptocephali and the mature eels which descend to the ocean from September to November. What is the age of the Leptocephali taken in May and June? We have seen that the female

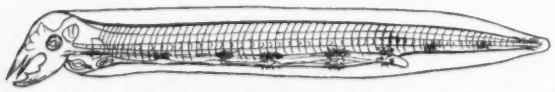

Fig. 3.—Larva hatched from egg shown in Fig. 2, three or four days after hatching.

conger probably spawns about six months after ceasing to feed, and if this is also true of the common eel the latter would spawn chiefly in March. This would leave three months for the development of Leptocephali taken in June; those taken in May may be derived from eels which migrated in September or the time of development may be only two months. In the case of other fishes such as flat-fishes we know that the whole metamorphosis takes only about three months. The Leptocephalus of the eel at the earliest stage taken by Schmidt in the Atlantic and by Grassi in the Straits of Messina is about 8 cm. or a little more than 2½ ins., but it is very narrow and thin, and contains little solid substance.

Our knowledge of the spawning eels in the sea, of the eggs, and of the earlier stages of the larva is still very incomplete and it is into this part of the life-history that further investigation is most needed. Specimens of the common eel in which the sexual organs were approaching the mature condition were taken by Grassi and Calandruccio in the Straits of Messina, many of them being found in the stomachs of Sun-fish; in some males among these ripe spermatozoa were found in parts of the testes. The only fully ripe male which has been seen was one obtained in a fjord of the island of Zealand, in Denmark, which was described by Schmidt; its occurrence so near the coast must be regarded as exceptional. With regard to the eggs and newly-hatched larvæ we know their general characters but cannot identify with certainty those of particular species. Schmidt obtained no eggs of eel or conger in the Atlantic, but as long ago as 1888 Raffele described several kinds of transparent pelagic eggs taken at Naples which have been universally recognised as belonging to species of Apodes, either Anguillidæ or Murænidæ. These eggs were distinguished by the large space between the enclosing membrane and the yolk, by the segmentation of the yolk itself, and by the larva hatched from them, which had an elongated form with many segments in the body and extraordinarily long projecting teeth (Fig. 4). It is evidently the earliest stage of the Leptocephalus larva. Grassi also obtained specimens of these same eggs at Naples, and suggested that one of them which was without oil-globules in the yolk was the egg of the common eel; but there is some reason to believe that the egg of the eel possesses an oil-globule. In July, 1901, Dr. Sargent of the U.S. Fish Commission obtained in the surface net, about 30 miles south of the South Shoal of Nantucket, some pelagic eggs which were taken alive to the Woods Hole Laboratory and described by Professor Eigenmann, who considered that they were probably eggs of the conger. They resembled closely one of the Murænoid eggs described by Raffele (Figs. 2, 3, and 4). The diameter of the membrane of these eggs was from 2.4 to 2.7 mm. The chief reason for Eigenmann's identification is that two species of Apodes, the eel and the conger, are found in the region where the eggs were taken, the conger having been taken on bottom lines abundantly in the same neighbourhood, while the

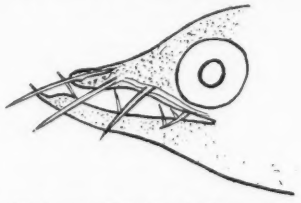

Fig. 4.—Head with jaws and teeth of a larva a day or two older than that shown in Fig. 3. After Eigenmann.

egg of the common eel is supposed to be without an oil-globule.

On the other hand, Schmidt thinks that the eggs of the eel, although in all probability transparent and pelagic, and of the characters already mentioned, do not normally float at or near the surface, but at a considerable depth below it where the water is somewhat denser. His chief reason for this view is that he took in 1905 along the 500 fathom line numbers of transparent pelagic eggs of the species *Argentina silus* and *Argentina sphyræna*, deep-sea fishes belonging to the family Salmonidæ, not at the surface but at depths of 250 to 300 fathoms. Experiment showed that these eggs sank in water of the density of that at the surface, but not in water of slightly greater density. He does not explain why the same net did not capture eggs of the eel if, as he suggests, they occur at the same depths, but the eggs of the Argentines were 3.4 mm. in diameter and those of the eel may be smaller and, therefore, pass through the meshes. Another possible explanation is that the eggs of the common eel occur only in winter, since the Leptocephalus is already fully developed in May, the earliest month in which Schmidt was able to work in the Atlantic; this, however, would not apply to the conger. If the eggs of eel and conger are usually bathypelagic they might, nevertheless, occur occasionally at the surface under exceptional conditions either of currents or density, as in the case of the eggs described by Eigenmann; and, further, if they are bathypelagic in the Atlantic they may not be so in the Mediterranean, where the water is denser, and this may be the reason why Murænoid eggs occur at the surface at Naples.

The Conservation of Mass.

By ALFRED W. PORTER.

(*Continued from last month, p. 50.*)

IN order to determine the velocity of the cathode stream more information is required than is given by the amount of its deflection in a magnetic field. This information is obtained by a method which was first of all suggested by Lenard, but was first carried out by Sir J. J. Thomson some years afterwards. If the stream is a veritable stream of charged bodies it must be deflected also by an electric field. Such a field of electric force can be set up by mounting two parallel plates one on each side of the negative electrode and using these plates as a plate condenser—each, for example, being attached to one of the poles of a large battery of accumulators so as to create a difference of potential between them. The electric force—that is, the mechanical force on a body carrying unit charge—will be the difference of potential divided by the distance apart of the plates. Call this electric force F. Then the force on a charge E is EF, and if the plates are arranged so that this force acts at right angles to the initial motion it will produce a deflection of the stream. It can easily be arranged that the direction of the force EF shall be opposite to that produced by a magnetic field; and if both fields are excited together their relative strengths can be adjusted so that no deflection at all occurs. In this case the opposing forces must be equal; that is,

$$EF = E\,v\,H,$$

$$\text{or } v = \frac{F}{H}.$$

If, afterwards, the magnetic field is alone excited, the stream bends into a circle the radius of which can be measured and then the equation (p. 50)

$$Mv = ERH$$

enables one to calculate the ratio

$$\frac{E}{M} = \frac{v}{RH} = \frac{F}{RH^2}.$$

This determination was not perfectly easy to carry out, because it is difficult to set up a known electric field in a vacuum tube when the gas is partially exhausted on account of the gas being an electrical conductor; but success was at last obtained.

It was found that when circumstances—such as the degree of exhaustion of the tube, or the voltage between its terminals—were changed the measured velocity also changed, though it was always very high, ranging from about $\frac{1}{50}$ to $\frac{1}{3}$ the velocity of light (*i.e.*, 3×10^{10} centimetres per second). The velocity, then, is an adventitious property. The ratio of E to M, on the other hand, is found to be of practically the same value under very varied circumstances. This is so even when different gases or electrodes are employed. We are justified, then, in regarding it as representing a more intrinsic property of the material of the stream than its velocity. The value found is about 1.7×10^8 coulombs per gram.

So far nothing has been said about the possible constitution of the stream; is it molecular like a stream of ordinary matter would be, or do we meet here with a new kind of material which is continuous? None of the experiments cited above give any indication whatever on this point; the same results would be obtained on either supposition. We have, in fact, postponed the introduction of this important question until its entry can be made logically. It is true that the possibility of the molecular constitution of the stream was present in the minds of investigators at a very early stage; but it must be remembered that investigation seldom proceeds along perfectly logical lines.

Of phenomena unknown until recent years the only ones which indicated that electricity may be molecular in character were those of electrolysis. The amount of silver set free in a voltameter is proportional to the quantity of electricity which has flowed through it. This would be the case if each silver atom moving down with the current carried a definite quantity which it gives up to the electrode. The same remark holds good for any other element; and, moreover, it is found that *the same quantity of electricity sets free the same number of atoms of a univalent metal, and half the same number of any bivalent element, and so on.*

Now, provided we restrict attention to any one element, all that can be concluded is that any atom has the power of handing over a definite quantity of electricity. But when we find that with different kinds of atoms it is the *same* quantity or a simple multiple of it, the conclusion seems irresistible that electricity, like matter, is molecular in character. It has been mentioned that Maxwell recognised the cogency of this argument, but he was not enamoured with it, for he was inclined to dispense with the idea of electricity altogether. To Johnstone Stoney must be attributed the credit of being so enamoured with the idea as to give a name to the unitary quantity of electricity; he called it an *electron*.

This idea of the possibility of the unitary character of electricity was present in the minds of investigators on the cathode stream. A comparison was at once made between the quantities given by experiments on the stream with the data of electrolysis.

In electrolysis we do not learn the value of the actual charge on each atom, but the charge corresponding to each gram set free. The reciprocal of this is, indeed, the *electro-chemical* equivalent. For hydrogen the charge which sets free one gram is about 96,340 coulombs; or, roughly, 10^5 coulombs. The same quantity sets free 108 grams of silver, 63.5/2 grams of copper, and so on. These numbers may be compared with the charge per unit mass on the cathode stream, viz., 1.7×10^8 coulombs per gram. The latter is 1,700 times the similar quantity for hydrogen; $1{,}700 \times 108$ times that for silver, and so on. Hence, in the stream, the mass associated with a given charge is only 1/1,700 the mass associated with the same charge in hydrogen, and is still less when compared with substances of higher atomic weight.

Several suppositions might be made in the attempt to make these numbers throw light on one another. In the first place it might be that in electrolysis the charge set free is only a small part of the charge on the atom. Electrolysis of a substance would indicate only the free charge; the behaviour of a cathode stream consisting of the same substance would depend upon the total charge. Another alternative would be that the substance in the stream is a new substance of moderate atomic mass and of very high valency; this is not a probable hypothesis, however. The third possibility is that the stream consists of atoms having the usual electrolytic charge and a mass only one 1,700th part of the mass of an atom of hydrogen.

This last turns out to be the right interpretation, but additional experiments of a new type were necessary to prove it. The most important of these does not, indeed, deal directly with the cathode stream itself, but with an ordinary gas made conducting by the passage

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through it of Röntgen rays. The gas is made electrically conducting by means of these rays, and it is supposed to carry a current in a way analogous to that of electrolytic conduction. If so, the gas is then full of charged centres (the *ions*); and the problem is not merely to find the charge per unit mass of those which are charged positively (say), which is all that can be done in electrolysis, but to measure the actual charge on an individual centre.

Use is made of the discovery of C. T. R. Wilson at the Cavendish Laboratory that these charged centres promote the formation of fog when damp air is suddenly expanded. It was shown by John Aitken some years before that, if damp air is perfectly dust free, no fog forms when a sudden expansion takes place; but if the air is dusty a fog forms. The formation of such a fog has been known for a long time to engineers, and it has important bearings on the performance of steam-engines. Moisture is deposited in this way in the cylinders of an engine, and since the moisture gives up its heat more readily to the walls of the cylinder than dry steam does, considerable loss of efficiency ensues—a defect which is removed in part by initially superheating the steam. Now, C. T. R. Wilson found, experimentally, that a gas may be absolutely dust free in the ordinary sense and yet a deposit of moisture occurs on suitable expansion if only the gas is previously ionised. Upon this new discovery Sir J. J. Thomson based a method for counting the number of centres corresponding to a measured electric charge. The moisture condenses as small drops on the electric nuclei. These drops fall slowly down under the action of their own weight. Their size is calculated from their rate of fall; the total volume of water condensed can be calculated when the amount of expansion is given; the ratio of the latter to the former, of course, gives the number of drops. The total charge on the drops can be obtained by the usual electrical methods. Thus, *if we assume that each drop contains a single atom of electricity*, the value of this unit charge is at once known.

Without detailing the earlier experiments on this subject we will next month describe some very recent determinations of this elementary quantity.

(*To be continued.*)

PROF. FRANK H. KNOWLTON, of the U.S. Geological Survey, has just published in the Smithsonian Miscellaneous Collections a short paper entitled, "Descriptions of Fossil Plants from the Mesozoic and Cenozoic of North America." The paper includes descriptions of two new fossil chain-ferns, the first of which, called *Woodwardia maxoni*, was found in the Fort Union formation near Rock Springs, Wyoming. It is of special interest from the fact that it is very closely related to the common chain-fern so widely distributed over eastern North America from Nova Scotia to Ontario and Michigan, and south to Florida, Louisiana, and Arkansas. The other new species, which he names *Woodwardia columbiana*, is from the Pleistocene and was found at the Cascades of the Columbia River in Oregon. It, likewise, resembles closely a living species originally described from Mexico, but also found in Guatemala, Arizona, California, and Washington. Prof. Knowlton also describes a *Dennstaedtia americana*, which is characteristic of the Fort Union formation, never having been found outside it. This fern has its closest affinity with a living species found widely spread over China, Japan, tropical Asia, Polynesia, and Madagascar. These three new ferns were found in excellent condition, showing the fructification, and are of special interest on account of their close resemblance to forms now living, a very unusual experience with fossil plants.

Cloud Observation for Weather Forecasts.

BY OUR BERLIN CORRESPONDENT.

METEOROLOGICAL investigation, with its main practical object, the forecasting of weather, has of late years found an efficient aid in the exploration of the free atmosphere by means of balloons and kites. Another method which, besides yielding extremely valuable data as to the weather to be expected in the near future, is accessible to anybody is the observation of cloud formation.

Dr. A. de Quervain, of Zurich, has been engaged for many years in observations of this kind, and has been successful in obtaining results of the utmost scientific and practical importance. His deductions are based on the familiar cumulus cloud of warm summer days. It has long been known that this cloud variety, when accumulating to heights of 6 to 7 km., will become a thunder-cloud, its high-floating top assuming the shape of a fleecy ice-needle cloud, and extending sideways in anvil shape.

Now, Dr. de Quervain has found the ordinary cumulus frequently to undergo an apparently quite similar transformation, which, however, takes place at a lower level, about 3 to 4 km., and thus does not lead to the formation of thunder-storms, but merely to the production of fleecy clouds. This form of cloud can be regarded as a presage of good weather.

Another variety, that of veil-shaped hooded clouds, had not yet been sufficiently explained. This will frequently encompass the top of quickly rising cumuli, and, until a short time ago, had been considered as mainly instrumental in the production of hail. However, as shown by Dr. de Quervain, this is not the exact explanation of the phenomenon. In fact, these clouds are always found to be intimately connected with existing fleecy clouds, and, on the other hand, are a presage of bad weather, occurring previous to thunder-storms. Even more reliable presages of thunder-storms are those remarkably delicate varieties of fleecy clouds which are mostly found floating at about 4 km. height; on a darker layer there are superposed delicate white heads representing miniature cumuli. The appearance of these lofty, curly heads (mostly early in the morning) safely presages a thunder-storm within twenty-four hours.

Of special interest is the fact that Dr. de Quervain, during the appearance of such clouds, was able to carry out some ascents of recording balloons, the data of which are particularly instructive in regard to the origin of these cloud varieties and their relation to thunder-storm formation. One of Dr. Quervain's conjectures, viz., that their occurrence coincides with the presence of a violent drop in temperature at a height of 2 to 4 km., has been borne out by these ascents. The accompanying photographs, which have been taken by the experimenter, represent these interesting cloud varieties. In Fig. 1, which shows a cloud to be considered as a thunder presage, the bright heads *c*, *c*, *c*, *c* of the top are distinctly visible. Fig. 2 represents a less frequent case, where these heads, floating at a height of $3\frac{1}{2}$ km., are growing into extensive cumuli, thus forming a huge thunder-cloud.

Other interesting observations were made as to the origin of cirri, of which nothing definite could so far be said. Many of these formations, in the experimenter's opinion, are derived immediately from the thunder-clouds above described, though they may not manifest themselves by electrical discharges.

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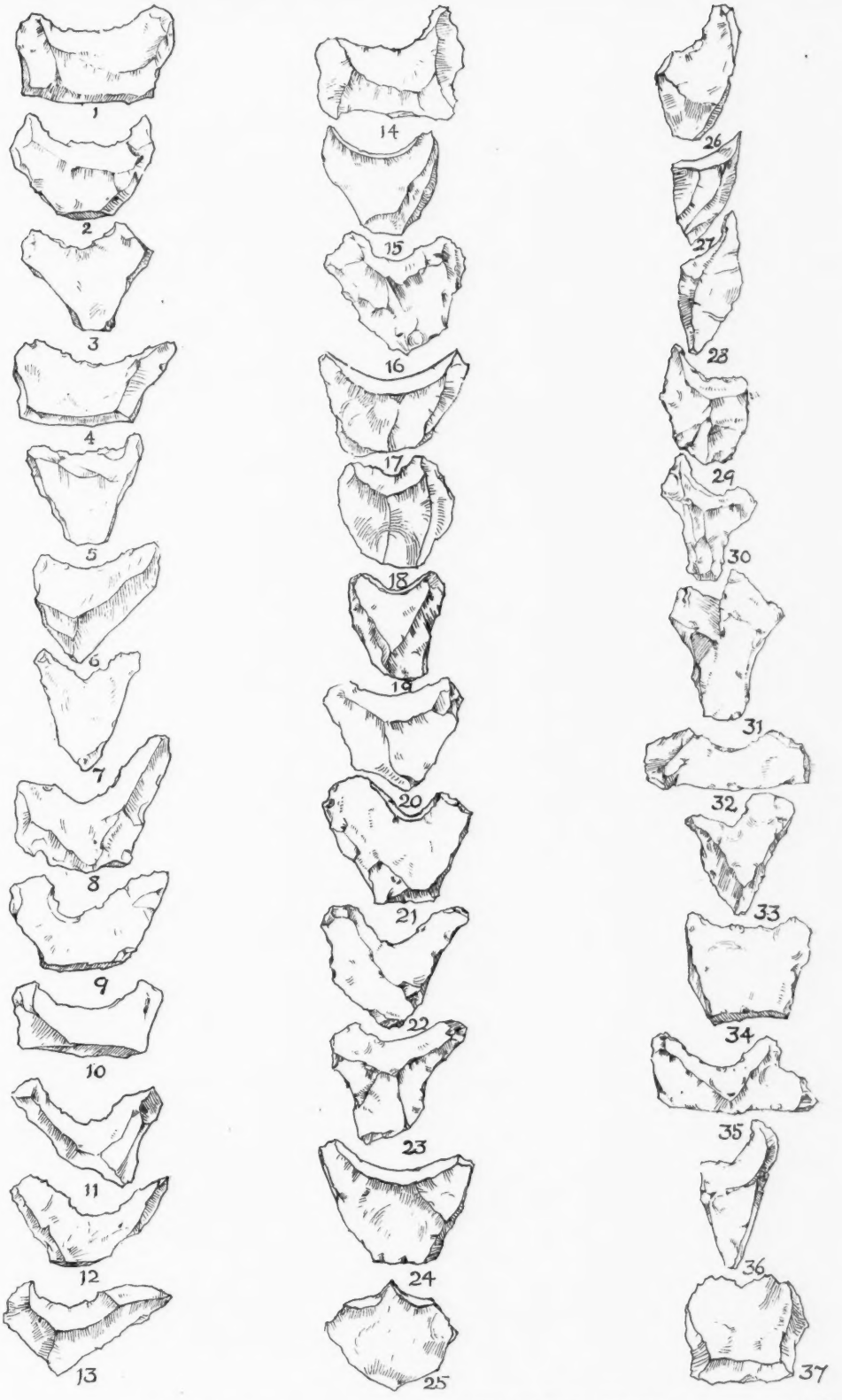

TOOLS OF THE STONE AGE.

PML.

Fig. 1.—Clouds with light tops (*c*, *c*, *c*, *c*) as presage of thunder-storm.

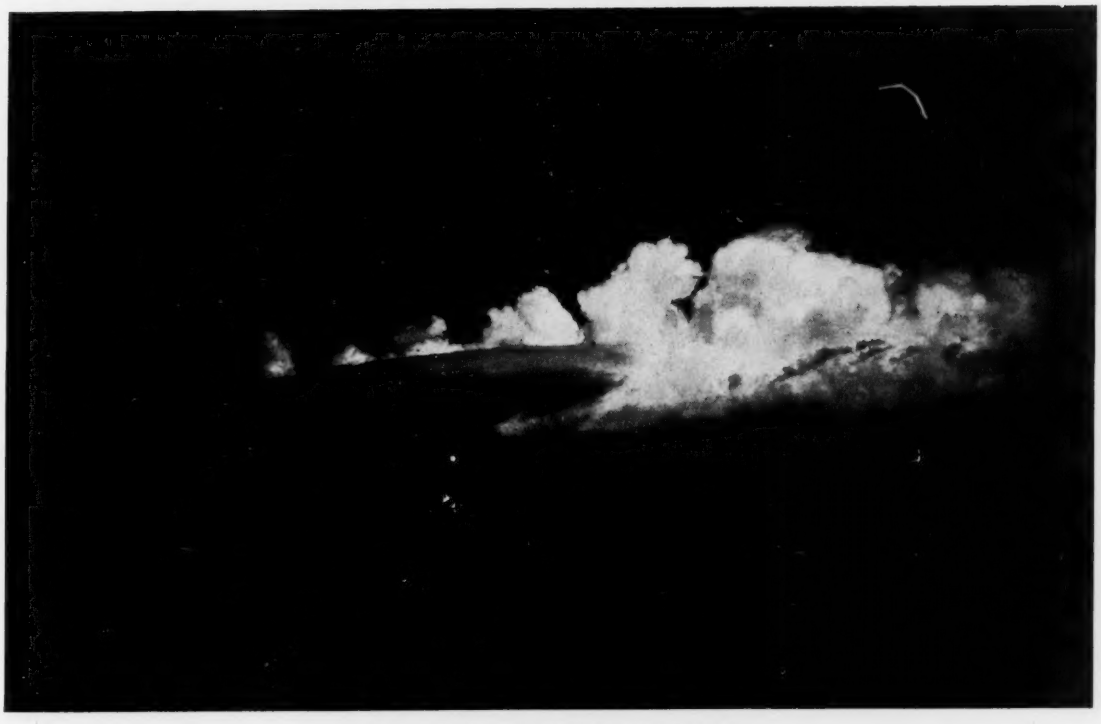

Fig. 2.—Cloud growing into big thunder-cloud.

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The Triphenylmethyl Problem.

By HERBERT H. HODGSON, M.A. (Camb.), B.Sc. (Lond.), Ph.D. (Heidelberg).

PART II.

TRIPHENYLMETHYL AND THE COLOUR PROBLEM.

THE remarkable substance designated triphenylmethyl arises when metals, *e.g.*, zinc, silver, or mercury, are allowed to act on triphenylchlormethane ; it is unsaturated to the highest degree uniting with oxygen and chlorine, also with ethers, esters, ketones, and nitriles to form loose compounds possessing characteristics very similar to those of triphenylmethyl itself. When exposed to air all these bodies are transformed into the extremely stable triphenylmethylperoxide, $(C_6H_5)_3$. CO O C. $(C_6H_5)_3$.

In addition to the above methods Schmidlin has shown the possibility of preparing triphenylmethyl by a reaction which takes place in two phases, viz.: First, the formation of the β-magnesium compound of triphenylchlormethane ; and, second, the action of triphenylchlormethane on this magnesium salt according to the equation :—

$$(C_6H_5)_3\,C\,|\,Mg\,Cl + Cl\,|\,C\,(C_6H_5)_3$$

β-magnesium triphenylchlormethane.

$$= 2(C\,H_5)_3\,C + Mg\,Cl_2$$

Triphenylmethyl.

In the year 1902 Ullmann and Borsum described a very stable hydrocarbon to which they gave the name hexaphenylethane $(C_6H_5)_3$ C. C.$(C_6H_5)_3$, and Gomberg therefore concluded that in triphenylmethyl there existed a carbon atom having only three of its valencies satisfied. Accordingly he wrote for the formula $(C_6H_5)_3$ C.

Triphenylmethyl in the solid state is colourless but forms yellow solutions. This property has led chemists to search for a relation between the colour properties which the triphenylmethane derivatives show in general (especially the dyestuffs of this class) and the colour exhibited by triphenylmethyl in the dissolved condition.

With this end in view Baeyer and Villiger expressed the opinion, in 1902, that the coloured compounds discovered by Norris and Sanders (formed by the union of triphenylchlormethane with metallic chlorides, such as aluminium, iron, and tin) are salts of triphenylmethyl which, under these circumstances, functions as a metallic atom. Further, Baeyer and Villiger have concluded that the carbon atom in triphenylmethyl possesses a special basic valence to which they have given the name "carbonium valence."

Since the common triphenylmethane compounds are colourless, Baeyer was compelled to assume the existence of an isomeric coloured modification. In triphenylchlormethane the coloured modification behaves as a salt whose chlorine, according to Baeyer, is easily ionisable, and between whose colour properties and this capability of ionisation exists a most intimate connection. Baeyer has avoided fixing further limits to this isomerism, and contents himself by saying that the isomerism must in some way be bound up with a diversity of valency. To distinguish this new valency, which serves as a carrier of ionisation and colour properties, from the ordinary carbon valency, Baeyer has named it "carbonium valence," expressing it in diagrammatic form by means of a zigzag line, *e.g.* :—

$(C_6H_5)_3\,C - Cl$ — Colourless.

$(C_6H_5)_3\,C \sim Cl$ — Coloured.

All authors agree to the existence of a loose union between the triphenylmethyl residue and the radicle combined with it in certain derivatives of triphenylmethane. The important questions for decision, however, are First, as to whether this loose union is present in the original normal derivatives, or only in those rearranged isomeric compounds which are affected by the carbonium valence ; and, second, the possibility of establishing more firmly, or even formulating in the garb of a structural representation, this isomerism which Baeyer has so indefinitely described.

The next stage was naturally the application of Baeyer's hypothesis to explain the constitution of the triphenylmethane dyestuffs. Triphenylcarbinol dissolves in concentrated sulphuric acid to give a yellow solution, the carbonium valence causing triphenylcarbinol to possess the property of forming a yellow coloured salt with sulphuric acid. We must conclude from this that the same carbonium valence in triaminotriphenylcarbinol serves to form an analogous carbonium salt: $(NH_2.\,C_6H_4)_3\,C \sim Cl$. In consequence of these novel ideas, Baeyer returned once more to the old formula of Rosenstiehl, and renewed the discussion of the reasons which had led to its previous rejection.

This new departure on the part of Baeyer as to the cause of colour was directly opposed to general experience. In the year 1868, Liebermann and Graebe had established a relation between the colour properties of quinones and their peculiar constitution. E. and O. Fischer had also added weight to the above principles by ascribing to fuchsine a formula analogous to quinone :—

$O - C_6H_4 - O$ — Quinone.

$(NH_2.\,C_6H_4)_2 = C.\;\;C_6H_4.\;\;NH_2\,Cl$ — Fuchsine.

These formulæ were modified by Nietzski in accordance with the later representation of quinones, *e.g.* :—

$O = C_6H_4 = O$ — Quinone.

$(NH_2.\;\;C_6H_4)_2 = C = C_6H_4 = NH_2\,Cl$ — Fuchsine.

Rosenstiehl waged an obstinate fight against these formulæ, his chief arguments being as follows : A water free base which should correspond to the quinonoid formulated salt did not exist, and if the salt existed as represented, then it was still able to receive two further hydrochloric acid molecules forming a triple acid salt as the highest degree of saturation. The researches of Baeyer and Villiger on triphenylmethane produced some representatives of those water-free quinonoid bases the existence of which Rosenstiehl had denied, and proved that phenylated quinonimines were especially stable coloured bases, *e.g.* :—

Fuchsonphenylimine, $C_6H_5\,NH = C_6H_4 = C\,(C_6H_5)_2$ and diphenylaminofuchsonimine (the aniline blue base of triphenylrosaniline)

$$C_6H_4.\;\;NH = C_6H_4 = C\,(C_6H_4\,NH_2)_2.$$

Rosenstiehl was still further wrong in his assertion that a triple acid salt could not exist, but only a quadruple having the formula $(HCl.\,NH_2.\,C_6H_4)_3\,C.Cl$. An investigation of this quadruple acid salt proved that no definite compound existed in the manner Rosenstiehl had stated, viz., as giving a fixed amount of hydrochloric acid. In addition the product had no fixed dissociation pressure, this varying continuously with the amount of combined hydrochloric acid, and therefore a well-defined compound was impossible. On the contrary, however, as soon as the composition corresponded to that of a triple acid salt, a constant dissociation pressure was obtained pointing to a well-defined chemical individual.

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The water-free colour bases, together with the certain proof of the existence of a triple acid salt and the absence of Rosenstiehl's quadruple acid salt, speak decisively against Rosenstiehl's formula, and therefore make more probable the quinone explanation.

At the beginning of his work Baeyer favoured the quinone formula as explaining colour phenomena, but the singular properties exhibited by even the simplest triphenylmethane derivatives caused him to put forward the idea of a special "carbonium valence" as a solution to the colour problem and the constitution of the triphenylmethane dyestuffs.

Starting from the quinone hypothesis Norris and Sanders made an attempt to write the formula of triphenylmethyl as a colour body, viz. :—

$$(C_6H_5)_2\,C = \langle\!=\!=\!\rangle \text{ II.}$$

This formula possesses a carbon atom having two free bonds at the position marked II. in the figure, and corresponds to a triphenylmethyl of empiric formula $C_{19}H_{14}$. If the above representation be correct, then Norris and Sanders explain the formation of triphenylmethyl as a splitting off of hydrochloric acid from triphenylchlormethane. Gomberg, however, proved conclusively that the action of metals on triphenylchlormethane was not to take away hydrochloric acid, but simply chlorine, and, therefore, triphenylmethyl must have the empirical formula $C_{19}H_{15}$, thus disproving the work of Norris and Sanders.

In like manner objection can be taken to Heintschel's biquinonoid formula :—

$$(C_6H_5)_2C = \langle\!=\!=\!\rangle\!-\!\underset{H}{\overset{H}{C}}\!-\!\langle\!=\!=\!\rangle = C(C_6H_5)_2.$$

Here the want of analogy is conspicuous, since the diphenyl group is only split off with difficulty as Willstätter demonstrated in the case of diphenoquinone.

Happily the idea of Jacobson appears to be capable of proof, viz., that the properties of triphenylmethyl are explicable, on the model of Bamberger's quinols, as being those of a carbon quinol.

$$(C_6H_5)_2\,C = \langle\!=\!=\!\rangle\!-\!\overset{H}{C}\!-\!C(C_6H_5)_3.$$

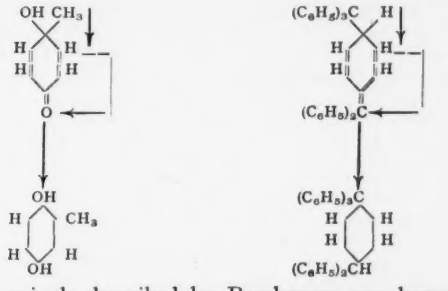
Triphenylmethyl exhibits the noteworthy property of rearranging itself in the presence of hydrochloric acid to form that particular hydrocarbon which had been discovered earlier by Ullmann and Borsum, and named by them hexaphenylethane. Tschitschibabin then demonstrated that this hydrocarbon possessed an hydrogen atom easily replaceable by bromine, and accordingly the formula must be written as benzhydryltetraphenylmethane $(C_6H_5)_2.CH.C_6H_4.C(C_6H_5)_3$. In addition, Gomberg determined the molecular weight of triphenylmethyl and found it to be $\{(C_6H_5)_3C\}_2$, *i.e.*, the double of $(C_6H_5)_3C$.

These facts brought the quinol formula of Jacobson into prominence.

Bamberger has shown that the quinols have a great tendency to reform the benzene nucleus, *e.g.*, in toluquinol the methyl group easily changes its place, wandering, as indicated by the arrow in the diagram, into the ortho position, while the hydrogen atom contained there changes the quinone oxygen occupying the para position into an hydroxyl group.

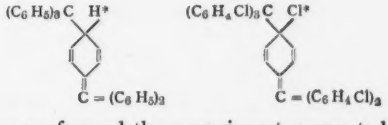
On analogy with the above a similar rearrangement of triphenylmethyl shows that the quinol hydrogen assumes the ortho position, as indicated by the arrow, and the hydrogen atom already there goes to saturate the double bonded carbon in the para position. In this way the quinolic is transformed into the benzene form :—

Toluquinol. *Triphenylmethyl.*



The quinols described by Bamberger are, however, colourless, as also, for example, quinonediimine, but Willstätter and Pfannenstiehl have shown, by making a comparison of quinone with Thiele's fulvenes, that, contrary to the current theory, the group C : NH is a weaker chromophore than C : O and C : C. It is therefore possible that C : O is a weaker chromophore than C : C, and the lack of colour exhibited by quinols instead of weakening the theory tends to prove that triphenylmethyl has colour as a carbon quinol, since the carbon double union must be regarded as the real carrier of colour.

Gomberg now began to search for experimental proof of a quinone formula for triphenylmethyl free from objection. He argued as follows : The Jacobson formula is characterised by having a relatively easy mobile hydrogen atom, denoted in the diagram with an *. If this mobile hydrogen atom be replaced by chlorine, then the relative stability of this chlorine atom may easily be established. By treating tri-para-chlortriphenylchlormethane, $(C_6H_4Cl)_3$ C., Cl, with metals, *e.g.*, molecular silver, a triphenylmethyl should be obtained having a chlorine atom in place of the mobile quinol hydrogen atom. In the diagrams below the mobile atoms are denoted by an *.



Gomberg performed the experiment suggested above, using molecular silver, and found that not only an atom of chlorine was split off from a molecule of the tri-para-chlortriphenylchlormethane thus forming the corresponding triphenylmethyl, but in addition a second chlorine atom was detached as expected on the above theoretical reasoning. A whole series of experiments with halogen substituted triphenylchlormethanes were conducted resulting in the fact that for a molecule of halogen triphenylchlormethane, 1½ to 2 atoms of chlorine were split off. For a constitution other than quinonoid only a single chlorine atom should be detached and that the carbinol chlorine.

Gomberg was thus brought to the conclusion that this second mobile chlorine atom could not possibly adhere to the customary benzene ring, but must be loosely united to such a quinone structure as the Jacobson formula requires.

(To be continued.)

Part III.—"The Quinone Structure in the Triphenylmethane Derivatives."

Some Tools of the Stone Age.

By A. J. HOGG.

ONE cannot take up any book on flint implements without frequently meeting with the terms *trimmed flake* or *worked flake*. These terms are, however, used in a generic sense, and convey no definite idea to the mind, serving only to denote a category in which every uncommon or unfamiliar implement may be included.

To this category the average collector consigns objects that are not figured by classic authors such as Evans or de Mortillet, or cannot be matched by specimens in the public collections.

The long rows of *coups-de-poing* which form so large a part of such collections, beautiful as they frequently are as works of art, are of little assistance to the student of pre-history, who finds in their monotonous numbers but repetitions of familiar forms.

To know the condition of man at a given period we require the objects which served for his daily use in the hut or in the forest; but these are represented by few and unclassified examples. Nor, indeed, do they attract much attention from the collector in the field, who as a rule, is in search only of such objects as are already well known; and the result is that science gains nothing from his industry, and specimens which might have elucidated some obscure question, or formed connecting links in the chain of evidence of the continuity of human progress, join the great company of *trimmed flakes*, without adding anything to the general sum of our knowledge of the pre-historic past. It is to obviate this, and to link together the Eolithic with the Palæolithic and the Neolithic men by their works which remain to us, that these little-known forms are helpful by showing that the needs of all these men were practically the same, and found their expression in the production of implements adapted to like uses, though differing in fashion from time to time, as do the tools of historic peoples.

In endeavouring to re-construct, as it were, the daily life of pre-historic man, it will, I think, be admitted that we can have no better material than the tools which fell from his hands. Some of these are known to us through the works of numerous authors since the days when the great work of Sir John Evans made its appearance; but there are many forms not yet noted, and much yet remains to be done before pre-history will be able to render its full measure of help to Geology in ascertaining the epoch at which the rise of man from the brute condition took place.

There must have been many implements required for the making of bows and bow-strings, and the fashioning and ornamentation of other weapons of war and of the chase, as well as in the everyday life of the family of which we know nothing, though we may expect enlightenment from the investigations into the habits and customs of aboriginal races now being prosecuted in so many directions, and which may result in our learning the use of these at present unexplainable forms. It is evident then, that the number of the known tools should be largely supplemented by the addition of such forms as from their frequent occurrence may be looked upon as fixed, or standard, types; so that when met with in the field or the gravel-pit, the collector may recognise that these "flakes" were not "trimmed" without an object, but were made by design, and in pre-conceived patterns.

Numbers of these forms appear and reappear in company with the recognised implements of every period down to the Bronze Age; though from the great variety of their shapes causing difficulty in arrangement, and from the impossibility of assigning to them any particular use they have been thrown aside and lost sight of; for when one is unable to imagine for what purpose a specimen could have been intended, the doubt arises as to whether it is really an implement at all. There is also an easy way of accounting for the less-known varieties of implements by styling them *natural forms;* though to what operations of Nature the production of so many series of distinctly separate types can be attributed I have not yet seen satisfactorily explained.

When writing on the "Primitive Character of Flint Implements," Prestwich says*: "It is the frequent repetition of the same form, as seen in a series of them, that the evidence of intelligent design strikes one most forcibly and convincingly. That hundreds of flints should have assumed the same general form without the intervention of human agency is so highly improbable that it approaches to an impossibility." This was written with reference to the then much discussed question of the authenticity of Eoliths, but appears quite applicable to the present subject. We cannot conceive that these objects were worked merely as an idle pastime, but must concede to the operator the intention of producing a weapon or a tool to serve some kind of use; whether intelligible to us or not, is of little moment, the constant occurrence of the same form is sufficient evidence of design.

In this connection the remarkable fact appears, that a large proportion of types are shown by archaic examples to have originated in the most remote period to which we have yet been able to assign the existence of man as distinguished from the brute; and these types have survived with modifications to the end of the Stone Age.

In Neolithic times the advanced conditions of life and of culture necessitated the employment of a much greater number and variety of tools than were required in remoter ages, and the large and ponderous implements became smaller and lighter, as well as more finished in manufacture. It is not, however, my present intention to point out differences of this kind, but simply to show a series of typical forms, which will enable the collector to identify his finds; although variations from every type will continually be met with.

As it would be impossible to apply intelligible descriptive names to so large a number of implements no attempt is made in that direction, and the numerical designations are simply for convenience of reference. I have thought it preferable to represent one specimen of each type, showing its actual details rather than to reproduce my generalised diagrammatic sketches, which, though combining characteristics not present in every example, would not lend themselves so well to critical examination. The arrangement of the tools is based simply on their form; and the presence or absence of bulbs of percussion, being matter of indifference, is as a rule not noted in the description of the various figures. These are not drawn to a uniform scale, the object sought being the presentation of the whole to the eye in one plate, for facility of reference. This could not have been attained by representing the implements of their actual or relative dimensions, some being very large and others very small; the sizes of each are, however, given in the description of the figures. These are all from examples found by myself, and mostly from the country around the little vil-

* Controverted Questions of Geology, p. 77.

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lage of Addington, in Surrey, a district containing much of interest to the pre-historian, and selected for that reason from my collection, which comprises gleanings from upwards of one hundred and eighty localities in twelve English counties.

The artist has not succeeded as well as might be wished in indicating some of the minor features of the implements, especially of the serration; but the outlines are correctly drawn, and on comparing a series of implements with the figures, and, keeping in view the more salient characters of each, I do not think it will be difficult to identify these as well as the seventeen forms of the saw figured in the October, 1908, number of "KNOWLEDGE."

It will greatly facilitate the recognition of the various forms of tools, as well as of other implements, if it be constantly borne in mind that "the Tool is opposite the Butt." This rule applies to all tools, excepting saws and knives, and to all weapons; for all start from the base.

It is not always easy to decide at first sight where the butt of an implement is situated, though the matter is simple enough in those of Neolithic age, owing to the frequent presence of bulbs or cones of percussion. It is generally that part of the tool on the finish of which least trouble has been expended, and always, except in the cases just indicated, opposite to the part where the traces of workmanship are most apparent.

DESCRIPTION OF THE FIGURES.

1.—This is one of the tools most frequently met with in deposits of all ages. The effective portion consists of a slightly concave serrated edge filling the space between two rounded extremities. The butt is broad and thick and the tool is always massive in proportion to its size; I have an Eolithic example from the Wandle gravel at Mitcham weighing 3 lbs. 5½ ozs. Several Eoliths of this type are figured by Prestwich in "Controverted Questions of Geology." Some are shown as "hollow scrapers" in Mr. T. P. Johnson's "Stone Implements of South Africa," they have also been met with in America. The specimen now figured was found on the surface and is of Neolithic age. Addington ½.

2.—This is lighter than No. 1, and the curve of the edge is more pronounced. The edge rises to a point at one of its extremities—occasionally at both—and the serration is coarser than that of the other tool, and the butt narrower. Addington ½.

3.—The serrated edge of this is almost straight, and one end is, as it were, cut off diagonally. The teeth are always coarse, and the butt is narrower, as if intended for hafting. The older specimens are very massive. The figure is from an Eolithic specimen of deep brown tint, found on the Chalk hills. Addington ½.

4.—The edge of this tool is intentionally serrated, and more or less concave, terminating in a round shoulder at one end, and a point at the other. The base-line is broad, and in some examples, especially those of the River Drift period, the body of the tool is curved as if bent; a good Eolithic example is figured by Prestwich.* The subject of our drawing, made from a grey mottled flint, is of Neolithic age. Addington ½.

5.—The edge is serrated, and straight, at one end rising suddenly to a point in well preserved examples. The point is, however, generally worn down by use, probably as a borer. The specimen figured is of grey flint, and of Neolithic age. Addington ½.

6.—This tool is commonly massive in proportion to its size, and the always finely serrated edge rises diagonally to a peak not sharp enough to be called a point. The example drawn appears to be of late Eolithic age, and came from the valley-gravel of Chipstead Bottom, Surrey. Chipstead ½.

7.—This rises from a narrow butt, and consists of a more or less deep angular, sometimes V-shaped cleft, the edges of which are thin and invariably coarsely toothed; the thinner side of the implement is also serrated. The specimen figured is of early Neolithic age. Addington ½.

* Controverted Questions of Geology, Pl. V., fig. II.

8.—This consists of one long serrated limb, issuing diagonally from a short broad base. The whole of the upper edge is coarsely serrated, and the end of the projecting limb is blunt. The tool, while varying much in form, always exhibits the long serrated limb. The figure is from an early Neolithic example. Addington ½.

9.—The working part of this implement is a coarsely-toothed edge occupying a hollow of some depth intervening between two limbs, which rise abruptly on either side of the hollow. The end of one of these limbs is usually bluntly pointed, and the other cut square. The coarse teeth of the edge, which are not the result of wear, may perhaps have been used to roughen the shafts of spears in order to secure a firm hold in the hand. This specimen is Neolithic, and was found near Croham Hurst. Croydon ½.

10.—The typical form of this tool has a straight basal line; from each end of this rises vertically a short limb. The intervening space is filled by a row of teeth, which form a slightly curved saw. The tool is usually massive, and in section triangular. This example is from the surface of Chipstead Bottom, and apparently of Neolithic age. Chipstead ½.

11.—The edge of this implement is slightly concave, and always serrated, and from one end issues upwards a long narrow limb triangular in section, and flat-topped. The serration of the edge is continued for the whole length of the projected limb. The specimen figured is of Neolithic age. Addington ½.

12.—This is one of the most variable of implements, but generally approaches in its outline to an obtuse-angled triangle; in some cases the lower angle is cut off so as to form a flat base, as in the specimen illustrated. The upper side has a slightly concave edge, serrated on its whole length, and terminating at each end in a limb, one of which has a pointed and the other a square tip. That the serration of the edge is intentional is proved by a small model in my possession, which was found near the site of a factory at Addington, where it probably served as a pattern to the workmen; it is made of a fine dark-coloured clay, and well fired. Addington ½.

13.—This tool has an angular base. The upper edge is sinuous, being concave for about one-half of its length, and convex for the remainder. The concave portion is intentionally serrated, and terminates in an abruptly rising projection; the convex portion has a knife-like edge terminating in a point. The form of this tool, which has a wide range, is very constant, and the graceful sweep of the convex portion makes it easy to identify. The specimen figured is of early Neolithic age. Addington ½.

14.—Described as a "beak-shaped scraper," by Prestwich,* and figured as "an unfinished arrow-head or hollow-scraper," by General Pitt-Rivers,† consists of a straight or slightly convex back, usually terminating at the end opposite the butt in a short blunt projection. The lower side, as unworn specimens demonstrate, is intentionally serrated—not worn by use—and ends in a peculiar hook formed by the junction of the curved edge with the almost vertical line of the broad end of the implement.‡ The short projection at the angle of the upper side appears in the less-worn Neolithic examples as a borer. This tool may have been used as a saw for round shafts; the hook giving a purchase which would facilitate the operation. An exquisitely worked example, evidently of the Solutréen period of de Mortillet, is in the collection of the Rev. J. D. Gray, of Nayland, by whom it was found at Santon Downham The present figure is from a Neolithic specimen. Addington ½.

15.—The well-known "shaft-maker" or "hollow-scraper," has an edge deeply concave, sometimes simple and sharp, sometimes worn by use, at others carefully toothed or serrated, so as to form, as Dr. Munro says, "a true saw." In most specimens one of the elevations on either side of the curved edge is sharp and the other blunt. The size of these implements varies much, some being small and suitable for making slender arrow-shafts, while others of larger size are adapted for shaping the thick shafts of spears, and their use for these purposes is unquestioned. They are found with remains of every period, not excluding the Eolithic. I have one weighing 3 lbs. 13½ ozs. from the gravel of Chipstead Bottom. The specimen figured is from the surface, and of late Neolithic age. Chipstead ⅓.

16.—Is more massive than the preceding, and is bevelled to

* Controverted Questions of Geology, p. 70, and Pl. IX., fig. 34.
† Excavations. Vol. IV., Pl. 311., fig. 7.
‡ The figure has been accidentally drawn wrong side up.

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a sharp concave edge, ending on one side in a rounded shoulder, and on the other in a short square-ended projection. The figure is from a skilfully chipped specimen found on a late Neolithic site at Addington, and is struck from a nucleus of mottled grey flint of good quality; the under side is smooth and unworked.

Addington $\frac{2}{7}$

17.—Has a thick and symmetrically concave edge forming a segment of a circle. The concavity appears to be the result of a single blow, as there is no secondary work. The form is sometimes so regular as to suggest the idea that these tools may have been used as gauges in making the shafts of spears and arrows. The figure is from a Palæolithic example found on the surface. Addington $\frac{1}{6}$.

18.—This tool is massive, and frequently triangular in section; the effective portion occupies but a very small part of the implement, and consists only of a shallow, sharp-edged notch produced by a bevel from one side, and generally narrower and more symmetrical than in the figure. The original is of late Neolithic age. Addington $\frac{1}{4}$.

19.—This is exceedingly massive; it consists of a shallow concavity in the thick edge, between two blunt projections or shoulders, from which the sides slope downwards to the narrow butt. The specimen figured was found on the surface at Southwold, and is made from a pebble from the Westleton Beds.

Southwold $\frac{1}{6}$.

20.—Is generally massive in proportion to its size; the sharp edge forms a wide and shallow curve, generally produced by a bevel from one side only of the implement. The figure is from an early Neolithic specimen, of light grey clouded flint.

Addington $\frac{1}{6}$.

21.—This peculiarly formed tool consists of a deep and narrow notch between two limbs, one of which is broad and flat-topped, and the other rounded at its termination. The butt is sometimes elongated as if intended for hafting. The specimen figured is of grey flint, superficially stained of a buff colour.

Addington $\frac{1}{6}$.

22.—This is a shapely and sometimes elegantly formed tool, the concave edge has a long and wide curve, rising on one side to a rounded projection, and on the other prolonged into a blunt point. The edge is rather finely serrated, though the teeth are sometimes almost obliterated by use; the base is commonly angular. The figure is from a Palæolithic example found at Addington. I have an almost identical specimen which I dug out, twelve feet from the surface, in sand forming the face of a vertical cliff at Easton Bavent, near Southwold.

Addington $\frac{1}{6}$.

23.—The stem or columnar portion of this is thick, and usually triangular in section. The upper part is bevelled to a sharp and slightly concave edge, which is never serrated, and is prolonged on one side into a short limb with quadrangular section, as if intended for boring. The specimen figured is of bright ochreous tint, and came from the surface of the high land above Addington. Addington $\frac{1}{4}$.

24.—This much resembles the preceding in shape, but is not bevelled to an edge, the upper portion being thick and smooth as in No. 17, while the projecting limb, which is also square in section, is longer and sometimes almost at a right angle to the thick stem or plinth. The example shown is of Neolithic age.

Addington $\frac{1}{6}$.

25.—This implement is short, broad, and flat, and consists of a thick edge of bracket-shaped outline, from the centre of which is produced a short borer, or drill as it has been termed. In Eolithic examples, which are large and heavy (occasionally weighing as much as 2 lbs.), the borer is very short, being perhaps worn down by use. The shoulders on each side of the point are never equal, one being invariably rounded and the other straight or sub-angular. The notch on the straight side of the illustration is an accidental defect. The tool persisted to the end of the Neolithic period, but while preserving its form became thinner and smaller, and the central point longer. Prestwich figures varieties of this tool as "bow-shaped scrapers."* They also appear among the "Implements of South Africa," described by Mr. J. B. Johnson. The original of the present figure is Neolithic. Addington $\frac{1}{4}$.

26.—Is confined to no particular period. The bulging outline of the thin edge forms a kind of ogee curve, and is usually serrated for its whole length. This serration is clearly intentional—not the result of wear. The tool is figured by Prestwich† in the work already referred to. The present example is of Palæolithic age, and was found on the surface of a ploughed field. Addington $\frac{1}{5}$.

*Controverted Questions. Pl. VII.
†Controverted Questions. Pl. IX.

27.—The stem of this is thick and elongated, and tapers towards the narrow butt. The upper part is bevelled to a strong sharp edge, straight or very slightly concave, from which rises on one side a short sharp spur or borer; the edge is never serrated. The subject of the present figure was found on the surface, and is Palæolithic.

Addington $\frac{1}{6}$.

28.—In this form the spur is prolonged into a curved spike of triangular section, evidently intended for boring. In the present specimen the concave side of the borer retains a sharp edge, but the convex side has suffered much from wear or rough usage. The lower part of the implement is thick, and tapers to a pointed butt; it appears to be of Palæolithic age.

Addington $\frac{1}{6}$.

29.—Is short, broad, and rather thick, and is bevelled from one side to a sharp concave edge, which is never serrated. This tool may have been used in the hand as a hollow-bladed knife or cutting instrument, and was perhaps mounted, like the Australian tool of similar form figured by Mr. J. Allen Brown.* The specimen now shown was found on the cliffs at Rottingdean, and is weathered to a white surface.

Addington $\frac{1}{3}$.

30.—Consists of a deep curved notch in the diagonally placed edge of the implement, which is developed from the upper part of a slender shaft. The edge seems to be worn by scraping. The implement, which was probably mounted, resembles one of the tools used by the Esquimaux to straighten arrow-shafts. The figure is drawn from a late Neolithic specimen, of light grey chertv flint, from the Addington Hills.

Addington $\frac{1}{4}$.

31.—This tool consists of a deep, angular, smooth-sided notch generally made in a thick block or nodule of flint. The notch is apparently the result of one or two skilful blows, and shows no sign of secondary working. In this instance the shaft slopes away to a tang-like butt suitable for hafting; but in some cases, where the implement is short, the wedge-shaped notch almost penetrates to the base of the butt. This specimen is made from an olive-coated flint from the bottom of the Thanet beds.

Botley Hill $\frac{1}{6}$.

32.—Has a sharp concave edge, usually produced by a bevel on one side of the stone, and forming a scraper or shave, apparently for use in the hand without mounting. In form it resembles the "crescent-shaped scraper," Fig. 13 of the Eoliths figured by Prestwich in "Controverted Questions." The present specimen, made of a grey flint, is, by its patination, of early Neolithic age.

Addington $\frac{1}{4}$.

33.—Consists of a short, sometimes curved point, rising from a doubly-curved edge. The base, which is straight, is opposite to the point, and the implement, evidently a kind of borer, varies much in form, and is almost exclusively Neolithic. The example, unfortunately represented on end in the Figure, is of late Neolithic age.

Addington $\frac{1}{5}$.

34.—This tool is massive and forms a short, thick wedge, the edge of which is always toothed like a saw; and is sometimes slightly hollowed. The butt is thick, and in the older examples has a peculiar twist. This specimen, which is evidently Neolithic, is of light grey flint and but little weathered.

Addington $\frac{1}{4}$.

35.—This tool consists of a thin, deeply concave, serrated edge, produced by a bevel on one or both sides. The base, which is perfectly straight, is prolonged on one side so as to form a handle, in a manner suggesting the idea that the tool may have been used in the hand as a curved or hollow saw. The specimen figured is Neolithic.

Addington $\frac{1}{4}$.

36.—In outline resembles No. 27, but its edge, bevelled on both sides, is toothed rather coarsely, and the projection which rises from one side is also bevelled transversely to a straight edge and has a row of finer teeth. From the edge, the tool slopes gradually to the thin and narrow butt, and it was evidently intended for mounting in some kind of handle. The example figured is of Palæolithic age.

Addington $\frac{1}{18}$.

37.—Rises like an axe from a massive base, and the upper and under plane surfaces converge so as to form a thin edge, which is rounded at each end, and indented in the middle. This central portion is always toothed like the edge of No. 34, and in both cases the serration is intentional and not the result of use. This specimen is roughly worked, and appears to be of Neolithic date.

Chelsham $\frac{1}{7}$.

*Palæolithic Man in N.W. Middlesex. Pl. V., fig. 10.

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The Evolution of the Bull-dog.

By W. P. PYCRAFT.

THOUGH the lion, from time immemorial, has been the emblem of the British race, nowadays the bull-dog is almost as commonly chosen for this honour. And this, professedly, because it is a peculiarly English breed, remarkable before all else for its pluck, determination, and powers of endurance. These excellent qualities, however, belong rather to the forbears of the bull-dog than to its modern descendants; they shine, a posthumous flame, fanned to life by modern enthusiasts anxious to rehabilitate a decadent race; and, perhaps, also, in a measure, to atone for past injustice. The modern bull-dog, like an extinct volcano, may be approached with a light heart, yet, probably, with most of us not without misgivings, for tradition reminds us that slumbering fires may yet be roused! Notoriously wanting in stamina, if amazingly improved in the matter of temper, the bull-dog, then, as we know him, is a creature of the stage, a pantomimic presentation of unbounded ferocity.

For something like 500 years the bull-dog was among the most highly-prized of dogs; then, of a sudden, came a revulsion of feeling, and the idol of our forefathers was hurled from its pedestal and spurned as one of the most ignoble of breeds, savage in the extreme, and fit only for the companionship of the most dissolute and brutal of men. For a decade or so this ban of excommunication remained in force; gradually losing virulence. One after another of his human detractors seem to have relented, and lo, in a little while, the name which was anathema became again a name to be held in honour. But the return to the old love has been marked by a most extraordinary transformation, and this in the short space of some 60 years. The nature of this transformation it is the purpose of this chapter to show. But before we enter upon this latter-day glorification it would be well to briefly outline what has been gleaned in regard to the ancestry of this dog and the factors which guided the earlier stages of its evolution. Than the bull-dog, indeed, it would be hard to find a better illustration of the effect of selective breeding, or of "artificial" as opposed to "natural" selection.

What manner of dog, then, was the ancestral bull-dog, and what was its origin?

As to the question of origin authorities differ, as authorities will; but the consensus of opinion seems to favour the view that the bull-dog is descended from the mastiff, that, in short, the original bull-dog was practically a small mastiff, used in hunting the wild cattle or "forest bulls" as they were called, which roamed over this country in earlier times. Up to 1174, indeed, they were apparently common in the country round about London, since Fitz Stephen, writing about this time, remarked that "close at hand lies an immense forest, woody ranges, hiding-places of wild beasts, of stags, of fallow deer, of boars, and of forest bulls." When the wild bulls became exterminated the dogs used in baying them were, it would seem, used for the purpose of "baiting" their domesticated descendants for the ends of "sport." Yet we find no mention of "bull" dogs till 1631, when one Prestwich Eaton wrote from San Sebastian to George Wellingham, of St. Swithins, London, for a mastiff and two "bull-dogs." All the same, bull-baiting had for centuries been assiduously practised, since records of this pastime date back as far as 1209.

Now, what is the evidence, it may be asked, that the dogs used in this brutal diversion were, if descendants of the mastiff, smaller than that breed? Of direct evidence there seems to be none, save that afforded by a few skulls, but the hint conveyed in Prestwich Eaton's request is significant. He asks for a mastiff—a large dog—and two bull-dogs, because, we may fairly assume, they were smaller. And the requirements of the sport furthermore necessitated a relatively small dog, but one of great strength.

The bull, in fighting, naturally lowers his head to bring his horns into play, and thereby also brings his

Head of Old-type Bull-dog.

nose—his most unprotected part—close to the ground, and out of harm's way. His tormenters, more to prolong their sport than from motives of humanity, often provided him with a hole in which to thrust it, and bulls who were seasoned hands at the game would scrape one for themselves with the fore feet. It was, therefore, necessary for the dogs to keep their heads low down, to "play low" in order to seize the first opportunity of gripping the vulnerable spot. Big dogs had to crawl on their bellies to achieve this end, and hence were at a disadvantage.

Thus, early in the development of this breed the object was to obtain relatively small dogs, broad, muscular, compact, of invincible courage and ferocity. A short face, powerful jaws and chest, are characteristics of the mastiff, what was required was to reduce the stature and increase the peculiarities of the face, shortening the nose so that the lower jaw became "underhung," thereby giving the beast a better grip and enabling it to breathe the more freely while hanging on, for once a hold was obtained there was no

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releasing! All these points were secured, and they persisted till the sport of "bull-baiting" was forbidden by law in 1835.

But long before this barbarous amusement had fallen into disrepute, and survived only among the more coarse-grained men, though these were to be met with among all ranks of society. Yet in earlier days bull-baiting formed one of the favourite amusements of the highest in the land. King John is one of the earliest sovereigns who patronised it; Elizabeth and Mary found it diverting, and James I. no less so. Indeed, when the Czar Nicholas of Russia was on a visit to England, before his accession to the throne, this monarch arranged a bull-baiting match for his guest's special entertainment. It has been contended, it may be remarked, that bull-baiting had its origin in an incident which occurred during King John's reign. For on a day, according to tradition, William, Earl of Stamford, from his castle walls saw two bulls fighting in a meadow, "till all the butchers' dogs, great and small, pursued one of the bulls clean through the town." The sight so pleased the Earl that he gave the meadows which formed the scene of this fight for a common to the butchers of the town, after the first grass was eaten, on condition that they provided a mad bull the day six weeks before Christmas Day, for the continuance of the sport, year by year. Tradition further has it that bull-baiting was commonly resorted to by butchers as a means of improving their beef, under the impression that an animal so slain was more tender than when dispatched by more speedy and merciful methods. There seems, however, to be no evidence for these stories, which have survived, probably, because from time immemorial the butcher has been regarded as the personification of whatever is coarse, and brutal, and ignorant. This is one of society's pleasant little ways of conferring distinction on those who perform most necessary, if disagreeable, work for the community! "Tradition," however, is an unreliable jade, and once more she has been "caught out"!

Head of Modern Bull-dog.

Though of unquenchable pluck, the old-fashioned bull-dog was of a morose and savage disposition, and possessed, apparently, no great intelligence. Yet there were exceptions to this rule. St. John, in his delightful "Wild Sports of the Highlands," tells of a bull-dog in his possession that possessed not only an affectionate disposition, but keen intelligence, and a no less keen nose. On one occasion, when deer-stalking in Ross-shire with some friends, a stag was wounded and got away. After other dogs had been put on the scent and returned, beaten, he sent for his bull-dog, which not only discovered the quarry, but pulled it down and dispatched it, tearing an envious rent in its throat; after a desperate struggle, as the surroundings showed. Having done this the dog returned and guided the stalkers to the scene of the encounter, much to their astonishment. Another story is told of a bull-dog which left a shipwrecked vessel with a rope round him and, swimming ashore, enabled rescuers to save the crew.

But these things cannot be said of the modern bull-dog; the decrepit creature of the show benches which, in acquiring his present-day ugliness and ungainliness, has lost his ferocity and most of his pluck. From a scientific point of view, however, this breed is of quite exceptional interest, for the remarkable transformation which the breed has undergone has taken place during the last sixty years or so.

When, in 1835, the temper of the times having changed, and bull-baiting was forbidden by law, the breeding of bull-dogs fell into abeyance and the race degenerated. It seems to have been saved from extinction only by the favour of men of the more disreputable sort who still cherished a hankering for the forbidden sport, and thus the race acquired an evil name. Good strains, however, still survived, and again the cult of the bull-dog was taken up with enthusiasm, but under new conditions and with new ideals, which were to exaggerate, in the greatest possible degree, the "points" which distinguished the older, parent, breed. The prize-winners at the modern dog-shows are witnesses to the success which has been attained. Good looks were never the boast of the bull-dog, and to-day his only beauty lies in his aggressive ugliness!

This is really a wonderful achievement. How wonderful only becomes apparent when the bull-dog of our forefathers' days is compared with that of the dog-shows of to-day. The breed derived from the great mastiff for centuries changed but little, and this because the environment was constant, so to speak, because any deviation from the type would have been speedily extinguished, being unsuited for the purpose required. When, however, it became a purely "ornamental" dog, a creature for the show-benches, so much more or less plastic material for man's experiments, new standards were set up, and lo, in about sixty years, a greater change than all the centuries had witnessed

was wrought. The taming of the shrew was as nothing to the taming of the bull-dog, and the transformation in bodily shape is no less remarkable.

That the loss of stamina, to which reference has been made, is a fact there is ample evidence. Glance, for instance, at the records of the prize-winners of to-day. Take the case of "Lucy Stone," bred by Mr. F. W. Jefferies in 1900. She died in 1903, though during this brief period she won no less than four first and five special prizes. "Neotsfield"—a male—born April 23, 1905, died April 4, 1906. Though but 11 months old he won several prizes; and one might add considerably to this list.

We cannot evade the fact that the modern bull-dog is a monstrosity, and this is borne out by an examination of the skeletons of such animals; and more especially is this true of the skull and teeth, which show all too plainly the results of high breeding. Each end of the bull-dog is remarkable! For a common character of the tail is a curious "kink," and in the skeleton this is seen to be due to malformed tail bones. So far as we can make out this broken-tail appearance was not so common in the older breed, and it is not a feature desired by modern breeders, and is apparently correlated with some other character, though so far no one has been able even to hazard a guess as to what this correlation may be.

Dog-breeders have achieved yet another triumph. Just as our forbears bred the relatively diminutive bull-dog from the great mastiff, so modern breeders have fashioned, so to speak, the toy bull-dog out of the modern bull-dog. These "toy" varieties are whimsical miniatures of the typical bull-dog of to-day for they differ from their prototypes chiefly in the matter of weight. The bull-dog of the shows weighs from 40 lbs. to 65 lbs.; the toy variety scales from 15 lbs. to 20 lbs. Imported into France the toy bull-dog acquired new characters, the most striking of which are the ears, which are carried erect and known as "bat ears," or "spoon ears," apparently as fancy dictates.

As an illustration of Darwin's "Animals under Domestication" it would be a difficult matter to find a better example than this of the evolution of the bull-dog.

THE new Egner and Holmstrom microphone transmitter was lately given a test on various long distances starting from Stockholm. Conversation could be heard as far as Paris, which is an exceptionally long distance for telephones on the Continent, or about 1,360 miles. The transmitter is based on the use of a light steel cylinder or flat box placed between the diaphragm and the carbon grains, so as to press with the flat bottom of the cylinder on a large surface of the grains. It will carry as high a current as one ampere and is thus exceptionally strong. The tests were carried out by the Swedish telephone administration, using a loop which passed through a distant city and then returned to Stockholm, and to a subscriber's instrument. Switching in the old transmitter and the new one allowed a good comparison to be made. Speech could not be heard on the standard system, but it could be well heard when the new transmitter was used on lines such as Stockholm-Helsingborg and return, or 1,920 miles. Tests were also made between Stockholm and Berlin, and at this distance, 780 miles, speech was as clear as on 100 miles of line on the standard system. Good results were had between the city and Cologne or, 900 miles, after which the coupling was made with Paris (1,360 miles) *via* Frankfort and Hamburg. A local line leading from Stockholm to Sundsvall (350 miles) was added to this, making 1,710 miles in all, and speech sent from Sundsvall to Paris could be well heard.

Musical Scales.

By JOSEPH GOOLD.

ONE of the most remarkable abuses of language that has got established in the course of scientific progress is that which may often be detected in a loose employment of the word "law." The laws of Nature are too frequently made responsible for conditions and effects which Nature has not produced and could not possibly alter—conditions which are themselves the very basis of her constitution. It matters not whether we speak of Nature or the Author of Nature. We cannot suppose God to make mistakes, and therefore we cannot suppose Him to do anything that is incompatible with the "laws" of the multiplication table or any of its corollaries such as the "law" of inverse squares or the "laws" of geometry. These things, so far as they are accurately expressed, are absolutely unalterable by any conceivable power; uncreated and uncreatable, they are laws of necessity but not of Nature. They are limits within which the laws of Nature operate; they may perhaps be described as compound axioms.

Let this suffice for the general aspect of the question; what I want to point out is that the mathematical basis of the musical scales has no dependence on natural law, but is also a form of truth neither creatable nor evolvable, but absolutely fixed and self-sufficient.

The evolution of man and his adaptation to the scale is quite another question.

Words may be used in different senses without much harm, provided that the intended meanings remain clear enough to be unmistakable. But in connection with the subject before us it becomes necessary to be especially vigilant, because Helmholtz has been quoted in support of the theory that the Harmonic chromatic scale is liable to evolutionary change;* and ingenious attempts have been made to oust it in favour of "Harmonic" fictions which are both flagrantly false and utterly superfluous.

The basis on which Alfred Day and his followers support their "Harmonic theory" is the blunder involved in the following miscalculation.

$$\frac{2}{1} \div \left(\frac{5}{4}\right)^3 = \frac{128}{125} = \frac{3}{125}$$

This misreading of a simple arithmetical expression results from the false assumption that a vibration ratio is a comparison of magnitudes; whereas it is a comparison of rates. Take a simple case. $\frac{5}{4}$ is the vibration-ratio of the major 3rd. The 5 and 4 here are not magnitudes but rates of vibration; and these *two* rates represent the *one* magnitude of the interval. An interval cannot be measured by vibrations, but only by intervals, because vibrations have no assignable magnitude. Roughly, the major 3rd measures 4 semitones; *i.e.*, $\frac{4}{12}$ths of an 8ve. More accurately it is $\frac{3{\cdot}86}{12}$ths or $\frac{17}{53}$rds or $\frac{193}{600}$ths.

So that 3 major 3rds $= \frac{579}{600}$ which is 21 of these small measurements less than an octave.

Now an equal temperament semitone (as on the piano)

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* See Prout's Harmony, paragraph 42, 7th Edition. Augener and Co.

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= 50 similar measurements; a major chromatic semitone D♭ to D = 46; a minor-chromatic semitone E♭ to E = 35.

Dr. Day would therefore have been much nearer the truth if he had said that the difference between 3 major 3rds. and one octave amounts to $\frac{1}{2}$ a semitone!

To find the precise measure of any given interval in terms of some specified fraction of the 8ve, we have to solve the equation $x = n \frac{\text{Log } a}{\text{Log } 2}$, where a is the given interval, n is the number of parts into which the octave is divided, and x is the number of such parts or intervals in the given interval. Fortunately there is now no question about the exact vibration ratios of the 12 notes constituting the Harmonic chromatic scale; they have been recognised and generally accepted for near upon 2000 years. What has not been recognised, however, is the true relationship subsisting between these undoubted ratios; the absolute symmetry of the system as a whole; the fact that this system is itself but the nucleus of an indefinitely extended system of precisely similar measurements; and the further fact that this unlimited system, in its mathematical aspect, is a function of the powers of the three simplest prime numbers 2, 3 and 5, being neither more nor less than the simplest products of their lowest powers; and that the twelve central products or scale-units (that is, the semitones of the chromatic scale) constitute the simplest possible division of the octave into twelve parts.

The following construction will show the actual constitution of the scale.

Starting with the key-note, which we will call C, the simplest measurement available is the perfect 5th G, 3 : 2. C G is therefore the *initial interval* in the foundation of the scale.

Repeating this same measurement above and below the initial interval, we get the series of 5ths.

F C G D (i.)

These are the fundamental notes of the scale; measuring now by a major 3rd (the next simplest interval) above and below each of these fundamentals, we obtain the complete scale, which, for convenience, we call the Harmonic System.

A	E	B	F♯
F	C	G	D
D♭	A♭	E♭	B♭

(ii.)

This is the natural chromatic scale of C, commonly accepted as the "Harmonic Chromatic Scale." Its corresponding vibration ratios are as follows:

5 : 3	5 : 4	15 : 8	45 : 32
4 : 3	1	3 : 2	9 : 8
16 : 15	8 : 5	6 : 5	9 : 5

(iii.)

There is no need to eliminate the octave element in these ratios, because harmony is essentially independent of octaves.

E.g. the root-ratios of D♭ and F♯ are no less than nine octaves apart:—

$$\frac{45 : 32}{16 : 15} \div \frac{45 : 1}{1 : 15} = 2^9$$

But this does not hinder their free use in any octave. (It may be worth while to point out in passing, that the root-ratios of the scale of C are all contained in the harmonics of D♭):—

Scale names . .	D♭	A♭	F	E♭	C	A	B♭	G	E	D	B	F♯	
Harmonics of D♭	1,	3,	5,	9,	15,	25,	27,	45,	75,	135,	225,	675	
÷ 15 making C the unit . .	$\frac{1}{15}$	$\frac{1}{5}$	$\frac{1}{3}$	$\frac{3}{5}$	1	$\frac{5}{3}$	$\frac{9}{5}$	$\frac{3}{1}$	$\frac{5}{1}$	$\frac{9}{1}$	$\frac{15}{1}$	$\frac{45}{1}$	
× powers of 2 to bring within the 8ve . .	$\frac{16}{15}$	$\frac{8}{5}$	$\frac{4}{3}$	$\frac{6}{5}$	1	$\frac{5}{3}$	$\frac{9}{5}$	$\frac{3}{2}$	$\frac{5}{4}$	$\frac{9}{8}$	$\frac{15}{8}$	$\frac{45}{32}$	

(iv.)

Referring to the scale-diagram (ii.), we have, by construction, a perfectly symmetrical system of measurements around the tonic-dominant centre C G; and we find, on examination, that these measurements are identical with the accepted ratios (iii.).

With these diagrams before us, the derivation of the "diatonic" scales becomes clear.

In each case they are simply convenient selections from the unalterable Harmonic system, arranged in order of pitch.

Taking the initial interval C G as centre, it becomes at once apparent that upward and downward measurements are equally distributed; the Major scale consisting of the four fundamentals F C G D (i.) and three upward measured 3rds A E B; whilst the Minor scale consists of these same fundamentals with three downward measured 3rds A♭, E♭, B♭.

This is known as the "natural" minor scale, and being, in its derivation, a downward measured scale, it becomes especially natural in downward passages. The sharp 7th commonly employed in cadences is, of course, borrowed from the Major mode.

The two scales are perfect mathematical inversions of each other, and therefore their true correspondence, note for note, is only seen correctly when their successive notes are read in opposite directions, thus:—

Major scale. .	F C G D A E B
Minor scale. .	D G C F B♭ E♭ A♭

Taking these pairs in their scale order we get the following scale forms, showing their mathematical relationship, and exhibiting absolutely identical measurements.

Major and Minor scales: natural order, showing identical intervals.

Major scale	C	8 : 9	D	9 : 10	E	15 : 16	F	8 : 9	G	9 : 10	A	8 : 9	B	15 : 16	C
Minor scale	G	9 : 8	F	10 : 9	E♭	16 : 15	D	9 : 8	C	10 : 9	B♭	9 : 8	A♭	16 : 15	G

(v.)

There is much to be learnt from a careful study of these unfamiliar co-functionaries of the two scales; but it must not be forgotten that we are here taking an analytical view of the subject; we are divorcing its mathematical from its corporeal elements.

This point involves a law of such importance in the constitution of the human mind that some explanation is necessary. We speak of the universal bias which leads us to think naturally in a positive way; to calculate with plus figures more readily than with minus ones; to measure upwards rather than downwards, &c.

Our very distinction between up and down must be due to this innate sense, analogous to gravitation, without which we could hardly conceive of magnitude or position at all.

The mathematical sense is essentially intellectual and works in either direction with equal readiness, but the corporeal sense, to which we are generally subject, being more instinctive in character, measures naturally upwards. Hence concrete humanity has a special preference for

upward measurement, but tolerates and enjoys judicious combinations.

Moreover to see the true significance of these strange mathematical antitheses, we must never lose sight of the fact that the Minor scale and the Minor key are two very different things.

In respect to its form, the Minor scale is a perfect reflection, and therefore an inversion of the Major scale. But for this very reason, it is—so far as the relationship between its form and its physical basis is concerned—an absolutely new system; because, although the form is inverted, the basis which gives it embodiment (that is the Harmonic system) remains unaltered.

It is this inverted *form* in conjunction with an unaltered *basis* which has obscured the *structure* of the Minor scale for 2000 years.

But the *Minor Key* is a composite system, consisting of the minor scale in conjunction with the most characteristic note of the major scale—the major 7th. This ensures a workable tonality; whereas the minor scale alone (as we shall see later) could not furnish a single chord (apart from the infirm Tonic) on which the ear might find rest.

The Minor Key therefore is welcomed as affording effective contrasts after prolonged major movements; but a whole composition of large extent cannot be restricted to minor harmonies without giving rise to a sense of depression and infirmity.

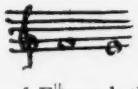
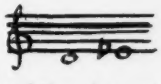
Considering now the Major and Minor co-functionaries above shown (v.) we may, in spite of their apparent incongruity, observe something of the functional qualities due to their mathematical correspondences. For this purpose it will be best to include the whole Chromatic scale as shown in diagram vi.:—

Mathematical Co-functionaries.

G	F	F♯	B	E	A	}	**(vi.)**
C	D	D♭	A♭	E♭	B♭	}	

C and G constitute the central functionaries: in Major and Minor alike C is Tonic and G is Dominant; but identical names do not make identical characters. In the Minor Key (especially in Tonic minor) the relative importance of the Dominant function is distinctly greater and more emphatic than that of the Tonic. This may be observed in the greater frequency and prominence of semi-cadences in the Minor key. In this key, too, there is often to be observed a peculiarly ominous or quasi-mystical effect—very valuable in dramatic passages—due to the mere iteration, or what may be called *martellation* of the dominant note—an effect which is never equally attainable in major movements, and which seems explicable only on the ground that—whatever names we may assign to them—Dominant and Tonic are the respective *Dominators* of the two keys; Dominant in Minor corresponding to Tonic in Major and *vice-versâ*. Some striking examples of minor-dominant predominance may be found in Mendelssohn's "Baal" chorus and "Whirlwind" chorus from "Elijah"; also in Mozart's "Dies Irae," &c.

D and F are the extreme fundamentals (i): just as F is the down limit of the Major scale, so D is the up-limit of the Minor. In seeking out the kinships of these co-functionaries it is well to remember that we must expect to find them illustrated by opposite melodic movement.

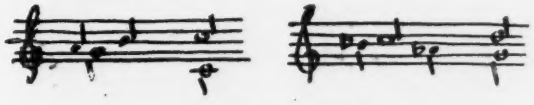
Thus  would correspond to 

D♭ and F♯ mark the harmonic limits of the chromatic system (see iv.). They may be called the Transition leaders. Just as F♯ leads *up* to F, the "Dominator" of G major, so D♭ leads *down* to C, the "Dominator" of F minor. They are seldom used in the same chord.

A♭ and B are evidently the Tonal leaders, leading up to C and down to G, the two "Dominators" of the complete tonality of the harmonic system. A♭—the minor 6th—as minor "leader" is frequently and effectively used to precede the Dominant on the bass in the case of a minor semi-cadence; and in numerous other cases it "leads" just as naturally down to the Dominant as B does up to the Tonic.

E♭ and E.—As everybody knows, these two notes form the distinguishing features of the two scales. As E is the 3rd up from its "Dominator" C, so E♭ is the 3rd down from its "Dominator" G.

B♭ and A.—These two notes have this in common, that they are the least characteristic of the co-functionaries. Also, they are the only two notes whose harmonic ratios fall exactly within the limits of the 8ve (see iv.). Both of them are employed chiefly as auxiliaries to their respective "leaders." Thus:—



(To be continued.)

Cinematograph Pictures of the Invisible.

By DR. ALFRED GRADENWITZ.

THOUGH endeavours have been made from time to time to produce moving pictures of microscopic preparations, satisfactory results have not so far been obtained except in the case of the most modest enlargements.

Dr. J. Comandon, of Paris, has recently succeeded in making the world of the microscopically small accessible to cinematographic illustration, reproducing with all the details of their motion not only the most minute microscopic organisms, but even those which are too small to be recognised by even the most powerful microscopes.

It will be remembered that some years ago was invented by two physicists, Drs. Zsigmondy and Siedentopf, an apparatus called the "ultra-microscope," which enabled particles of nearly molecular dimensions, which are quite invisible under the microscope, to be observed and investigated. Instead of illuminating these particles from underneath as with the microscope, they projected on them sideways a powerful beam of light, so as to make the particles self-lighting like minute stars. This method has been recently applied to investigations of bacteria. In producing moving pictures of invisible small organisms, Dr. Comandon, therefore, had recourse to a combination of this ultra-microscope with the cinematograph.

The ultra-microscope comprises the following parts: A microscope provided with the parabolical lighting outfit, an electrical arc lamp, and a glass ball filled with water, which serves as a lens for condensing the beam of the lamp on the mirror of the microscope. The cinematographical outfit is applied to the microscope through the intermediary of a bellows, and is operated on an optical bench, its very substantial support allowing any vibrations to be avoided as far as possible.

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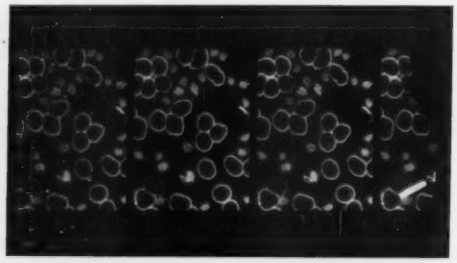
The cinematograph can thus be placed at any distance desired from the microscope. It was supplied by Messrs. Pathé Frères, the well-known film manufacturers.

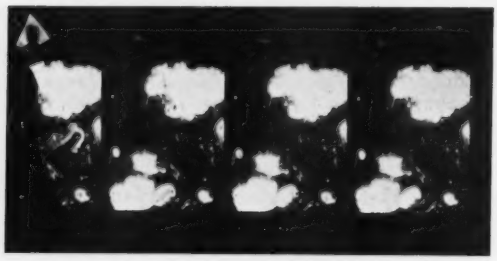
By means of this arrangement the experimenter has been in a position to obtain moving pictures of practically anything seen in the ultra-microscope. The views projected on the screen are so very much enlarged that, *e.g.*, the red corpuscles of the human blood may attain 15.3 centimetres in diameter, though remaining perfectly well defined.

The views are taken as far as possible at the normal rate of the cinematograph (16 pictures per second, *i.e.*, 1/32 second to each picture)

When moving over the projection screen at some speed these photographs represent the appearance of those ultra-microscopic preparations with remarkable faithfulness. While being of great help for scientific instruction and popularisation, these films afford the



Cinematographic Film of Frog's Blood partly Hæmolysed.



Cinematographic Film of *Spirochætes* of Teeth (negative).

invaluable advantage of allowing the fleeting and necessarily short lasting aspect of ultra-microscopical preparations to be preserved indefinitely.

Moreover, by studying separately each single picture, the movements of micro-organisms can be decomposed in a similar manner as Marey has resolved the gait of man and the flight of birds.

These views can be employed also for the numerical calculation of minute elements, which, owing to their mobility, could not otherwise be numbered. Those small movable particles of the blood which are called "hemokonies" can, for instance, be investigated in this manner. Previous experiments having shown these particles to be produced by the fatty elements contained in food, Dr. Comandon has confirmed these results by direct observation with the cinematograph. He thus found .72 particle to be contained in each corpuscle of the blood of a fasting bird, and 12.5 particles in the blood of the same bird after the absorption of oily grains.

The moving pictures of microscopic and ultra-microscopic scenes, of which the accompanying photographs only give a faint idea, reveal to the observer a new world full of strange wonders. A tadpole tail thus appears as a mass of cells traversed by a river of blood in which the blood corpuscles are whirled along like pebbles in a swollen mountain brook. A drop of bird's blood shows lengthy red corpuscles moving slowly in a liquid dotted with minute white spots. These are the particles called hemokonies, the presence of which indicates that the bird has had fatty food a few hours before.

Other scenes of a truly dramatic character reveal the struggle of the blood against the parasites infecting it. In some parts of South America the poultry yards are decimated by a certain microbe called "spirochætes gallinarum," which is closely related to one of the most dreaded parasites attacking the human species.

In the moving picture of the blood of an infected fowl these parasites are seen as spiral filaments, moving rapidly along the blood corpuscles in the manner of eels, both backward and forward. Sometimes one passes through another so as to form chains of two or three spirals jointed to one another. Suddenly one of the quickly moving spirals will enter a hole in a red corpuscle which has been attacked, and remain imprisoned therein turning violently round itself in a vain effort to find an outlet. Others are caught in the same trap, but succeed in making their escape. A large white corpuscle moving slowly in the manner of an amœba meets with a deteriorated red corpuscle, which it envelops and proceeds to absorb. On the background of this strange scene are seen as before the same bright oily globules called hemokonies.

Another series of moving pictures shows a drop of the blood of a mouse infected with a trypanosome nearly related to the germ of sleeping sickness. Though being only from twenty to one hundred thousandths of a millimetre (1/1,250 to 1/250 in.) in length, they appear on the projection screen like caterpillars several inches in length, moving in about the same manner as caterpillars, by the aid of an undulating membrane. They are seen rushing violently against the red particles of the blood, which, being elastic as billiard balls, give way to the shock, in order afterwards to resume their spherical shape.

One of the most serious difficulties encountered in this work was due to the intense heat given out by the beam of light, which sufficed after a short exposure to kill the microbes moving in the preparation. This drawback was obviated by means of a rotating disc composed of full and hollow sectors arranged alternately, which turned around at the very speed of the cinematograph, so that these small organisms were submitted only for 1/32 of a second to the heat of the rays, the latter being intercepted during a period of equal duration. Moreover, before traversing the ultra-microscopic preparation, the beams passed through a cooling water reservoir, where part of the radiation was absorbed.

WITH the ordinary moving picture machine photographs 2.5 by 1.9 centimetres are taken at about the rate of 16 per second, which is much too slow for taking a picture of a bullet or other projectile in flight. Even if the rates were 60 per second no satisfactory results could be obtained. In a recent number of the *Zeitschrift Instrumentenk.*, C. Cranz describes a ballistic cinematograph apparatus which gives a time interval of 1/5000 of a second, so that shot photographs can be readily obtained, and from these the velocity of the shot can be found. The pendulum used makes electrical connections at different points of its swing, and these are utilised to obtain the photographs.

Some Notes on the Ecology of Adoxa Moschatellina, L., the Moschatel.

By A. R. HORWOOD.

THE Moschatel is a plant which is inconspicuous enough, perhaps, growing in woody places and shady hedge-banks, in hilly country, in ash-woods, on clayey ground, and sometimes on sandy banks. It is fond of clustering in and around the roots of trees or right under a hedge where nettles form a protective advance-guard and other hedge-row plants also tend to hide it.

As regards its distribution in the British Isles, it is found in England, Scotland, and Ireland. Its northern limit in Scotland is Avoch, Perthshire, ascending to 1,000 metres on the Breadalbane Mountains (according to F. B. White). In Ireland it is found in Antrim. It is found in North and Central Europe, and ascends to the Alpine region. It is known in Northern Asia, and in South Europe is found at high elevations. It is found in North America, extending into the Arctic districts.

It is a perennial plant, flowering in April and May, and taking some time to mature its fruit. It is often infested by a fungus, *Puccinia adoxæ*.

It is the monotype of the order Adoxaceæ, of which it constitutes the single genus with one species. In Great Britain it is a common plant occurring in 98 out of 112 vice-counties (S. of Perthshire). Some difference of opinion exists as to its exact affinity. Bentham and Hooker assign it to the Caprifoliaceæ. Till then it had been placed in the Araliaceæ as allied to *Aralia*. Some authors adopt a middle course and place it in a separate family, Adoxaceæ, with affinity (though not very close) to Caprifoliaceæ. A few authors, again, upon anatomical evidence, have suggested its alliance with Saxifragaceæ, but upon these points see Schumann (Morph. Studien).

F. N. Williams* points out, in placing it in the Adoxaceæ, that it is allied to Caprifoliaceæ, though, as he says, "the absence of a true calyx, the false duplication of the androecium, and the character of the inflorescence are of heterotypic significance."

It may be that its generic name (Adoxa) was applied to it by Linnæus in allusion to its habit of hiding itself away, or to another—the formation of its fruit—upon which we propose to enlarge later, since the etymology (ἀ, privative, δόξα, appearance—or inconspicuous) may be applicable to either characteristic. As the specific name implies, it has a musky aroma.

A short description of its main characters will make these notes more complete.

Adoxa moschatellina, LINNÆUS (GENERA PLANTARUM, 1737, p. 118).

Commencing at the *rootstock* there is really no true root, but a monopodial creeping rhizome, covered with scales, vestiges of the leaf-stalks, shining white, succulent, with small pointed soboles, and quite glabrous, hence the delicate white thread-like subterranean connectives may be drawn out from the clay in quite a clean condition. The *stem* is solitary, unbranched, quadrangular and flexuose, and varies from 3—8 inches in height, being erect, and bearing leaves in opposite pairs, with flowers on long stalks with four basal and one terminal flower. The *petiole* is 4—6 inches, slender and sheathed at the base. The *flower-stalk* is radical, with two leaves once ternate near the top. The *leaves* are stalked, once, twice, or thrice ternate with three lobes, with broad segments and mucronate lobes. The *flowers* are pale yellowish-green, with a pinkish tinge when somewhat advanced, varying to buff, consisting of a whorl of four (5-merous) with a fifth or terminal one (4-merous)* arranged in a globular head, which is sub-quadrangular and described as a dichasial cyme. The *calyx* is bifid in the uppermost flower, and the corolla 4-merous, and there are eight stamens united in pairs, really equal to four. In the lower flowers the calyx is trifid and is regarded by some as an involucre with bracts and bracteoles,

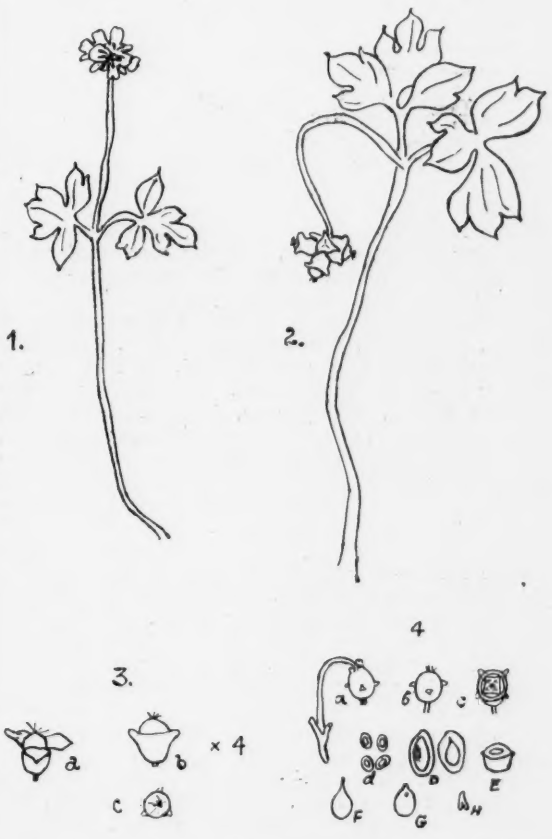


Fig. 1.—Flowering stem, showing the flower in an erect position. (*Nat. size.*)

Fig. 2.—Flowering stem with mature fruit, showing the peduncle hanging down, and in a patch of the plant growing under a hedge is quite hidden below the leaves. (*Nat. size.*)

Fig. 3.—*a*, Fruit—anterior lateral view, showing the calyx-segments *b*, Lateral view of another. *c*, Fruit seen from above. *a*, *b*, *c* × 4.

Fig. 4.—Copy of Gaertner's figures (De Fructibus et Seminibus Plantarum, Pl. 102).

The following is the explanation of the figures given by Gaertner:—"*a*, *b*, Bacca integra. *c*, Eadem dissecta, cum foveolis, positionem seminum indicantibus *d*. *D*, Semina integra, ab utraque parte spectata. *E*, Semen transverse dissectum. *F*, Albumen propria sua membrana vestitum. *G*, Ejusdem sectio verticalis, cum situ embryonis. *H*, Embryo solutus et insigniter auctus."

N.B.—The illustration is reduced to ⅔ the original drawing, and fig. 3 is therefore × 3, the rest three-quarters nat. size.

* "Prodromus Floræ Britannicæ," 1909, Pt. V., p. 209.

* In these respects like *Ruta*, etc. (Willis, "Flowering Plants," 897, p. 8.).

but this is probably incorrect. The corolla in these lateral flowers is 5-merous, and there are 10 stamens. The calyx tube is ½-inferior hemispherical, and 2-3 cleft, even 4 cleft (according to Gaertner, "Fructibus et Seminibus Plantarum," 1791, Vol. II., p. 141).

The *corolla* is superior, rotate, with a short tube and spreading petals, with 4—5 lobes, with which the stamens alternate. The *stamens*, 8—10, are in pairs, inserted on a small ring at the base. The *anthers* are one-celled and peltate. There is no disc. The *styles* are variable, from 3—5, and are often united, whence they were originally probably four in number. The stigmas are terminal. The fruit is a berry-like drupe, green and fleshy, with several seeds or stones. It is unilocular, sometimes containing but one seed. The ovary is semi-inferior, with ovules obovate, pendulous, 4—5 celled. The seeds are elliptic, compressed, slightly convex or concave, with membranous margin.

Withering says the fruits are red when ripe, but this we have not noticed. According to Willis (Dict. Flowering Plants, *loc. cit.*), "Honey is secreted round the top of the ovary. The chief visitors are small flies, attracted by the curious musky smell."

Whether fertilisation is effected in *Adoxa* by means of flies, as in *Arum*, is by no means certain. That it is so occasionally may not be doubted. But in a large number of cases this is not so. The plant is hermaphrodite and is autogamous, being self-pollinated. For, as in the case of many plants with erect peduncles, the filaments become elongated during the flowering-stage, being raised to the level of the stigmas which were originally above them. The anthers approach the latter and autogamy is the result.

When the embryo begins to form the calyx segments enclose the lower portion of the fruit and form the posterior portion, so that, according to the number of calyx segments (three or four), the fruit is triquetrous or quadrangular in cross-section bassally when mature. It has much the appearance of *Trapa*.

Gaertner has noticed the mode in which the calyx segments are involved in the formation of the fruit, which is, in itself, evidence that the calyx is not to be regarded as an involucre. He says (*loc. cit.*, p. 141), describing the perianth :—

"Bacca ovato-globosa, circa medium adnatis, sibi calycinis denticulis sub-quaternis stipata, semipellucida, pulposa, unilocularis, ex viridi pallida. Pulpa ante maturitatem firmula, seminibus arcte adhærens, ut tamen hæc eximi queant, et quatuor potius foveas, quam vera loculamenta post se relinquant; post maturitatem autem, ne fovearum quidem vestigium remanet."

We give a copy (Fig. 4) of his drawing of the fruit, since it differs somewhat from our own (Fig. 3), taken from a specimen collected at Tilton, Leicestershire.

In his Prodromus (*loc. cit.*, p. 209) F. N. Williams, in regard to the fruit, says :—

"The distribution of the plant in this country is probably more extensive than is indicated in floras; for the reasons that it is not a conspicuous herb; is found nearly hidden about the roots of trees, is easily overlooked, flowers early in the year, and its fruit is rarely observed, both flowers and fruit readily escaping notice from their insignificant size and colour. In *Fl. of Herefordshire*, Mr. Purchas says that he has hunted for the fruit in vain."

This, indeed, seems to be the experience of others, and it appears to us worth while to draw attention in this note to the contrivance adopted by *Adoxa* when fruiting to conceal the ripened seeds. The annexed rough sketch gives an idea of a flowering stem (Fig. 1) in which the flowers are seen to be quite erect.*

When, later, the fruit begins to swell, not only does the flower-head become heavier, but it begins to bend downward in the manner indicated, so that the fruit hangs down some distance below the leaves themselves (Fig. 2), whereas in flower, or just after flowering, it stands an inch or so above. The curve of the peduncle in this fruiting stage reminds one of the graceful curve in the swan's neck, and if it be likened to a bird plunging the beak downward into the water in search of mussels, the resemblance between it and pendant heads of *Adoxa* in fruit is most striking. The mode in which some Hydrophytes, in fact, bring about the safe germination of the seed, after flowering, above water, is very similar.

There is, doubtless, in this contrivance an instance of the adaptation of structure to surroundings. A mass of *Adoxa* in fruit, growing along the bottom of a hedgerow, would be a most welcome source of food to young birds such as thrushes and young robins, hedge-sparrows, etc., just at a time when other food of a similar character is liable to be scarce.

If the fruit were matured with the flower-head erect it would be unlikely that the plant would long survive, if only capable of spreading by means of seeds. This, however, is not the case, for it is soboliferous and could dispense with the propagation by ripe seeds, but the fact that these latter are completely hidden below the mass of foliage, so much so that it requires considerable experience to find fruit, even when it is plentiful, seems to point, we consider, to the employment of a double contrivance for ensuring propagation.

It cannot be urged that the flower-head hangs down when the fruit is mature simply because of the weight of the head. But it is a fact that the head is heavier when the fruit is maturing, and the most reasonable inference is that the contrivance is protective. If it were merely due—without any direct connection with protective devices—to the weight of the head it is certain that there would have been a readjustment of the whole proportions of the plant, and the stem would have been correspondingly thickened to effect this. The same kind of protection occurs in *Fragaria*.

A REMARKABLE phenomenon was observed during a thunder shower in Finland in the summer of 1908 by V. J. Laine, who was making meteorological observations for the Finnish scientific society. The shower approached from the east and the thunder, which had been heard at intervals during a half hour, ceased before any rain fell at the place of observation. During approximately the same half hour the eastern horizon was completely spanned by a double rainbow, which likewise vanished before the rain came. Immediately after each peal of thunder the colours of both bows, and especially those of the secondary bow, became confused and indistinct, and the whole double rainbow appeared to vibrate rapidly. Laine explains this singular phenomenon, in accordance with the Airy-Pernter theory of the rainbow, by assuming that the concussion of the air which produced the sound of thunder, also increased the diameter of the rain drops from less than 1/250 inch to between 1/50 and 1/25 inch. If this assumption is confirmed it will furnish a valuable contribution to the theory of thunderstorms, which is still incomplete.

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* It is then that the musky odour is given off and attracts young flies.

Restoration of Paleolithic Man.

By RICHARD SWANN LULL.

(Contribution from the Paleontological Laboratory, Peabody Museum, Yale University.)

AN attempt has recently been made by the writer to restore in plastic form the type of mankind dwelling in Europe during a portion of the Paleolithic period and variously known to science under the names of *Homo primigenius, neanderthalensis* or *mousteriensis*. The restoration, which is life size, is a tentative one and will be kept in the clay for a time in order that authoritative criticism may be met before it is cast in plaster (cf. Plate I).

Restoration of Paleolithic Man.
(From the *American Journal of Science*)

The model is based mainly upon what is known as the "Man of Spy No. 1"; one of the two specimens found at Spy in Belgium, of which the museum contains excellent plaster casts. The illustrations of the remains of man found at Krapina in Croatia and described by Professor Gorjanovic-Kramberger in his "Der Diluviale Mensch von Krapina in Kroatien," 1906, were largely used, together with certain other measurements, such as the estimate for total height, etc. For the use of the casts and the assembling of data, together with kindly criticism, I am indebted to Dr. George Grant MacCurdy, Curator of Anthropology in this museum, while to Professor Joseph Barrell, who has taken a very lively interest in the work, I wish also to acknowledge my gratitude.

My conception of *Homo primigenius* is that of a man of low stature, standing only five feet three inches in height, but of great physical prowess as indicated by the robustness of the limb-bones and especially of their articular ends. The great paunch of the higher anthropoid apes, which are almost exclusively vegetarians, is lacking and in its place is shown the clean-cut, athletic form of torso such as one sees in the typical North American Indians, for I imagine food conditions were much the same. We have abundant evidence that Paleolithic man was a crafty hunter, for the remains of various animals which he slew for food are found in the bone breccias of the caverns wherein his own relics are entombed. Great power is indicated, however, in the upper portion of the trunk and in the arms, compensating this ancient type for his lack of adequate tools and weapons.

The knees are somewhat flexed as the curved thigh bone would indicate, and probably should be more so, and the trunk is only partially erect, for the inward curves of the back bone, so characteristic of modern man, are but feebly developed, as in the case of babes of the present day or in individuals bowed down by the weight of years. The shin is relatively short, as with certain present-day races, and the great toe somewhat offset though having long since lost its ape-like opposability.

Restoration of Paleolithic Man.
(From the *American Journal of Science.*)

The head shows the prominent supra-orbital ridges above the deep-set eyes; the low, flat forehead; the broad, concave, nasal bridge and the somewhat prognathous jaws. The lower jaw is deep and powerful, and lacks the characteristic chin prominence of modern man. Other restorations give a greater prognathism than mine, and it may be that here I am in error in showing too great a refinement of countenance as compared with the low type of calvarium. The contour of the jaw is based upon actual measurement of one of the Krapina specimens and one should bear in mind that the far older jaw recently brought to light at Heidelberg, though of a more brutal type than any yet known, shows less dental prognathism than do the modern negroes, indicating a very great antiquity for the radiative evolution of the several human stocks.

In all probability the men of that day were much more hairy than the model would indicate, as they had little or no clothing and the climate, during part of their

racial career at least, was severe. They were, however, cave dwellers and knew the use of fire. I have purposely refrained from indicating this conjectural character, as it would, to a certain extent, conceal the conformation of the underlying parts.

A jaw of the cave bear, *Ursus spelæus*, a contemporary animal, though now long since extinct, is borne in the left hand, while the right contains a chipped stone implement from one of the typical stations, thus indicating the cultural plane of the race.

This type dwelt in Europe before the last glacial period, estimated at from 100,000 to 200,000 years ago, and continued for a long period of time, for his remains are found entombed successively with both cold and warm climate animals. The relics are found within or near rock shelters and caves, the best known of which are those of Neanderthal, Germany; Spy, Belgium; Krapina, Croatia; Le Moustier and La Chapelle-aux-Saints in France. As a race *Homo primigenius* is to-day entirely extinct, though whether he was blotted out or absorbed by the invading horde of the superior *Homo sapiens* we have no certain knowledge. Occasionally, however, something of his type appears in modern man, notably in St. Mausberg, a medieval Bishop of Toul, and in Lykke, a scientific Dane of the eighteenth century, as well as among Australians and Melanesians, the lowest living races of mankind. These may be looked upon as instances of atavistic reversion.

The "Man of Spy," while showing more pithecoid characters than his successor, was nevertheless eminently human, representing as he does the type just preceding modern man, and one far removed from a true ape-like ancestry. In the popular conception "Prehistoric man" should be gorilloid, or at any rate distinctly simian; against this misconception the model stands as a silent protest.

Solar Disturbances During January, 1910.

By FRANK C. DENNETT.

JANUARY was marked with very unfavourable meteorological conditions, which militated against regular work, though not to so great an extent as in December. The longitude of the Sun's central meridian at noon on January 1 was 72° 4′.

Nos. 145, 147, 148, and 149 appearing on the chart are the legacy left from last year, remaining visible until January 3, 5, 8, and 2 respectively.

No. 1.—A curved line of pores 41,000 miles in length only seen on 2nd.

No. 2.—A pair of pores only recorded on 7th.

No. 3.—A spot visible 10th to 21st, solitary except on 13th, when a pore was visible south-south-east; at the same time a whitish film seemed spread over the eastern part of the umbra. On 14th, the inner edge of the penumbra was brightest. Its diameter on 16th was 10,000 miles.

No. 4.—A spot also 10,000 miles in diameter, visible 19th to 29th. Tiny pores were visible east and west on 20th. One south-east on 21st, when a bright bridge crossed the umbra from north to south. A triangle of pores south-east on 22nd, one remaining 24th to 26th, none being seen later. On 25th and 26th the inner edge of the penumbra was bright. The group had a length of 53,000 miles.

No. 5.—A group of pores 34,000 miles in length 20th to 23rd, one pore remaining until 25th.

No. 6.—A tiny pore amid bright faculæ, only visible 21st.

No. 7.—A very black pore only seen on 21st beside a bright bank of faculæ.

No. 8.—A spot 17,000 miles in diameter, seen January 21 to February 1. A small companion north-east on 25th, and two lines of three pores each south on 26th, some continuing until next day. A narrow, bright bridge cutting off the western portion of the umbra was subject to much variation. The penumbra showed an inner brightening on 25th, 26th, 27th, and 31st.

No. 8*a*.—A group of pores probably also connected with No. 7. Three pores seen on 23rd, changing and dwindling until 26th, reviving greatly on 27th, developing into two irregular spots on 31st, amid a considerable faculic disturbance on February 1. It was simultaneously with this revival on 27th that Comet 1910*a* shot out a considerably increased length of tail. The length of this spot disturbance was 60,000 miles.

No. 9.—A spot 9000 miles in diameter, seen January 23 to February 3, somewhat shrinking during the transit of the disc.

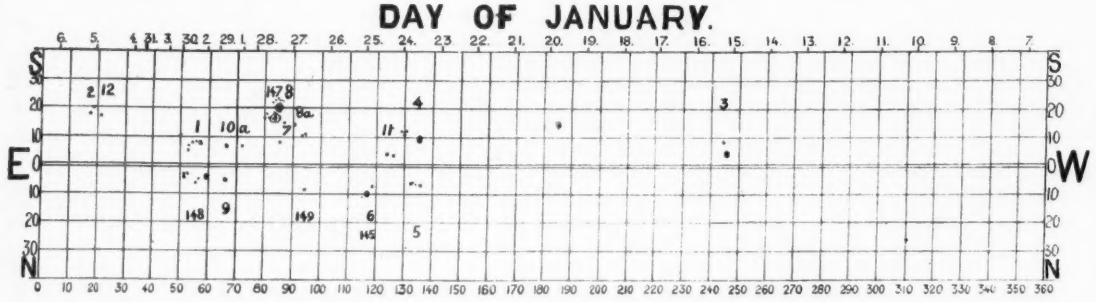
No. 10.—A spotlet south-west of a strikingly shaped faculic disturbance, only seen 23rd to 25th.

No. 10*a*.—A pore became visible on 27th only, very close to the same place.

No. 11.—Two pores 15,000 miles apart, only seen on 26th.

No. 12.—A small penumbraless pore with bright rim, seen January 29 till February 1.

The chart is constructed from the combined observations of Messrs. J. McHarg, E. E. Peacock, W. Strachan, and F. C. Dennett.



Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

The Action of Light.

The action of light is too often considered to be of a specific kind instead of regarding light as a source of energy, comparable to heat, which can produce changes of all kinds according to circumstances. It is, therefore, pleasing to see the variety of changes that H. Thiele records as the result of the action of the ultra-violet from a high tension Heræus mercury lamp. Hydrogen and oxygen combined, whether moist, or dried with scrupulous care; carbonic oxide and oxygen combined; hydrochloric acid and hydrobromic acid were decomposed by air; hydrogen peroxide was occasionally formed from water and oxygen; the decomposition of hydrogen peroxide, potassium percarbonate, and ammonium persulphate was much accelerated. Formic acid, ammonium oxalate, peptone, and albumen were more or less decomposed. Potassium nitrate was broken up into the nitrite and oxygen, and a piece of filter paper (cellulose) lost appreciably in weight. The oxidation of sulphur to sulphuric acid in the presence of water and air, which did not proceed to a measurable extent in the dark and only slowly in sunlight, was so hastened when placed very near to the source of ultra-violet light that nearly one hundred times as much acid was produced in three hours as the sunlight had yielded in three days.

Gelatine and Allied Bodies.

Mr. Charles W. Gamble has contributed a paper on this subject to the Manchester section of the Society of Chemical Industry, which is printed at page 65 of the current volume of the Society's Journal. He gives many results of his investigations which deal not only with the general characters of the bodies, but also their behaviour when mixed with an alkali bichromate and exposed to light. The collagens in certain animal tissues when treated with hot water yield gelatine, the solution of which, if not very weak, sets to a jelly on cooling. Of all the products in this series, gelatine gives the greatest proportion of insoluble matter when exposed to light with a bichromate, as in carbon printing. By the further action of water or its equivalent (hydrolysis) the gelatine solution loses its power to "set" on cooling. This product is gelatose or meta-gelatine, and still yields a large proportion of insoluble matter if mixed with a soluble bichromate and exposed to light. In general terms, this is the substance used by the photo-engraver. By continuing the hydrolysis, the gelatose, in turn, is changed into gelatine-peptone, which does not form any insoluble matter when bichromated and exposed to light. The changes are not sharply defined. Mr. Gamble has investigated the effect of the presence of gelatine-peptone, which is always present to a greater or less extent in gelatose, in that form of gelatose used by photo-engravers under the name of "fish glue."

Steepness of Gradation.

In these pages for January last in the section on "Playertype," I referred to the details of that process as being such as would give the steepest gradation or the greatest contrast in the resulting print. I have been asked to expand the few lines that refer to this subject of gradation. It may be possible to give a few generalities, but it must be understood that they are nothing more than suggestions as to the direction in which to work for a given result. Sensitive materials are not always simple, that is, they are not always plain emulsions of a single sensitive salt. Then it is very easy to lose a little possible advantage by a slight error of judgment. For example, over-exposure, as everyone knows, tends to flatness if it passes a certain point. If, therefore, one has two printing papers, one less sensitive than the other and normally giving a steeper gradation, if the difference in sensitiveness of the two papers is over-estimated, then if the fullest contrast is secured in the more rapid paper the other will be over-exposed and, perhaps, give a flatter result, which may be perfectly clean and satisfactory to look at, although this paper is really able to yield a more vigorous print than the other. Again, sensitive materials of the same sensitiveness vary in their power to give contrast. If an emulsion from which great contrast may be obtained is spread in too thin or too diluted a layer, "starved of silver," clearly the contrast possible in a richer coating will be unattainable, not because of any essential shortcoming in the material, but merely because there is not enough of it. There may be other affecting circumstances that do not occur to me at the moment, but obviously some of these causes of what may, in a sense, be called irregularities are beyond the control of the photographer.

Granting such possibilities of exceptions, other things being equal, a slower material will give more contrast than a more sensitive material, a chloride paper than a bromide paper, a paper with a shiny surface than a paper with a matt surface. A developer that is less sensitive, either inherently so, such as hydroquinone or glycine, or made so by adding restrainers, will give greater contrast than a more sensitive developer. But if any of the usual developers is allowed to act until the action is complete, the contrast is not dependent on the developer, it is simply a matter of the amount of developable silver salt present. But here, again, is a notable exception. If the developer does not contain sufficient sulphite, the coloured product of oxidation of the developing agent may spuriously reinforce a flat image and make it vigorous. This is why the older workers often objected to the use of sulphite, they needed this colouring matter to supplement the insufficient amount of silver. Whenever such need exists in average cases either the plate or the worker is at fault. If the subject lacks contrast there are other and sound methods of making up for it. The colour of the light affects the gradation. Red gives a steeper gradation than green, green than blue, yellow than white, and so on. But if a negative has a red image, instead of the pure grey as it should have, blue light would give more contrast in the print than red light, because the red image would be practically black to the blue light and transparent to the red light. The image may be only partly reddish (containing oxidized developer) and this may more than neutralise the steeper gradation that the red light gives. A negative will give a more vigorous image by enlarging in a lantern, or, more properly speaking, printing in any way so that the printing surface is removed from the negative (whether enlarged, reduced, or printed the same size matters nothing), than by contact printing. This is because in contact printing all the light that passes through the negative is available for the printing, but in non-contact printing the scattered light, which forms a notable proportion of the whole, does not go to form the image, and as the effective light is reduced, the result is as if the negative were blacker—that is, more vigorous. As to the amount of the change in vigour that these procedures make possible, it must suffice to say that they are generally of practical importance in print making.

XUM

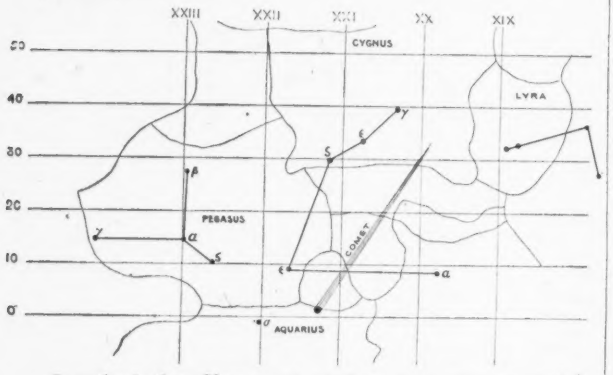
CORRESPONDENCE.

The Weather and Some Naked Eye Astronomical Observations.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—In common, apparently, with some other parts of the world we have been experiencing some very extraordinary weather. As a rule during January we get continuous hard frost down to zero Fahr., and sometimes below, with more or less clear skies, but this year, with the exception of the dates of the observations given below, the sky has been densely overcast and the sun very rarely seen, changing from a dripping thaw to frost often in a few hours, and continually varying from winter to spring conditions and *vice versâ*.

On January 8, from 4.50 to 5.20 Pacific time, I saw Mercury about an hour after sunset in a clear sky and then bad weather intervened till the 13th, when I again saw him about 6° above my horizon and 9° west of the new moon till he set at about 5.40. From the 13th to the 26th the weather was again bad, but on the latter date, whilst walking home from Vernon in a southerly direction, I noticed a large comet with long, straight tail in the south-west which was visible till after 7 p.m. I had no star charts at home, and, besides, did not arrive in time to make any proper observation, and it did not clear again until the 1st of this month, when I made an observation with the naked eye as per sketch enclosed.



I noticed that Venus set at 6.30 p.m. on my watch (Pacific time within 5 minutes), and I had seen the comet for nearly half an hour previously.

The head set at 7 p.m., at the same time as a star, a little to the south, which, I believe, but am not absolutely sure, was α Aquarii. I noted that the head was a dull nucleus like Mars with long, straight tail like bright northern light, nearly 33 degrees in length. The sketch shows such stars as I noted, all of which I am fairly certain of, except, perhaps, α Aquarii. I may add my south-west horizon is mountainous, and my latitude and longitude approximately 50° 12′ north and 119° 18′ west of Greenwich.

I have since seen it reported in the Press that it is like the great comet of 1882. I presume this must mean spectroscopically, because I saw the latter comet whilst on a voyage from Buenos Ayres to Southampton on board the R.M.S. Packet "Guadiana," and I remember distinctly that the tail was broad and short, with a curious flashing, waving motion, whilst the present comet's tail is like a long, bright ray of light, more like the great comet of 1861 as drawn by Chambers, July 2, Plate XXIX., Vol. I., Book IV., 1889 edition Chambers' Handbook of Astronomy, which, as regards the tail, also resembles the drawing of Biela's Comet by O. Struve, February 19, 1846 (Chambers, page 408).

In this connection I should be glad to hear if it is *at all possible* that this can be a return of Biela's Comet or not?

Yours etc.,
FRANCIS R. JOHNSON, M.Inst.C.E.

Vernon, British Columbia, Canada,
February 8, 1910.

P.S.—When we do get a clear sky here it is generally very clear, as the annual rainfall is only about 12 inches, and humidity, as a rule, low.

Astrology.

SIRS,—May I be allowed to add a few words to Mr. Arthur Mee's letter on a subject which, at any rate, is interesting. I have for several years past made a study of astrology and have come to the conclusion that there is some truth in the science, but that its interpretation is so difficult that it must be to some extent speculative—possibly some students may be helped by intuition. Judging by the map of the heavens for the time of my birth, and that of several of my friends, I have no hesitation in saying that in many important features the science has been verified; that is, the aspects in the horoscopes correspond more or less closely to the circumstances, character, etc., of the persons, according to the rules of the science. It is without doubt a very ancient, if not the most ancient, science, and the substitution of the Copernican for the Ptolemaic system of astronomy has not affected astrology, except in a few details. But the great question remains, Is it reasonable to believe that the heavenly bodies influence terrestrial beings? Is the symbolic meaning attached to the planets by all the nations of the East, mere fancy? I cannot think it, though it does not present a complete key to the riddle of the universe. But we know that every atom of matter in the universe acts upon every other atom, and that the planets, as electric orbs, influence individuals is no mere superstition. Nor is it necessarily fatalism, or to use a better word, determinism; for it may be an *influence* only, and not a force which cannot be counteracted. And it is not atheism, for the laws of the universe are absolute, and as F. W. Robertson says, "Law is the Being of God." I am glad that the science has among its investigators so great a name as the late Dr. Garnett, of the British Museum, whose work, "The Soul and the Stars," is very helpful to all interested in this recondite subject.

Yours, etc.,
H. A. BULLEY.

Brighton,
February 7, 1910.

SIRS,—As an old astrologer of over twenty-five years' standing I cordially welcome Mr. Arthur Mee's conversion and characteristic letter in your January number. I happen to know some of his colleagues in Cardiff, and I am quite sure that the mathematical side of astrology will appeal to him and them, and receive the attention it deserves. There is, indeed, "something in it."

Mr. Mee and his coadjutors will be interested to learn that we have a similar society here, similarly constituted and meeting in a similar place (viz., a Nautical School). If I am not mistaken it was also born at the same time! Ours, however, may be regarded as a kind of offshoot of the local lodge of the Theosophical Society. We find it difficult to separate the two subjects.

My friends and I are looking forward with great interest to the result of this generous opening of your columns to an unbiassed discussion of a very old but badly-treated science.

Yours, etc.,
A. E. LARKMAN.

Larkman's Academy, Southampton,
February 17, 1910.

SIRS,—*Re* Astrology*—As one desirous of knowing "the truth of the matter," would you kindly permit me, through your columns, to ask your correspondent, who has so thoughtfully come forward to assist "ignorance" and "prejudice" out of the mire encircling astrological difficulties, which one of the three systems, the Chaldaic, the Ptolemaic, or the Placidian, is the best; or, whether he has by some divinatory flash, or by a luminous intuition, been enabled to penetrate the whole secret; or, has found something more than has as yet been made known; within the short period of about three years; and if he has devised a system, one that appeals to him and produces a "positive immense body of truth," when does he intend favouring us with it in book form?

Sirs, to test, scientifically in particular, nativistic prognostications within a brief period of, say, about three years and attain such *remarkable results* seems to me rather an

* See "KNOWLEDGE," February, 1910, p. 65.

extraordinary feat; yet I am not going to deny Mr. Mee's assertion that "there is something—and a great deal—in it." But, there is too much for science and modern civilisation *in it*, however. If new-born babes' nativities have assisted the correspondent, I feel sorry for those little creatures. If, on the other hand, only adults have been tested, would Mr. Mee in his goodness of heart let us know whether a critical psychological analysis of his prognostications, and the mentality of his querents, has been made methodically. Querents *feel somehow* and *someway*, as a general rule, under the spell of astrological generalisations, rather happy, especially when they have been told in a rather shady and indefinite manner that something good is in store for them. A percentage of fulfilled presages would, indeed, be interesting. Of course, divinators through any of the mantic arts can give us, at times, much information about what has passed, but "it is not by making horoscopes agree with known facts that astrology is vindicated."

Your readers may be interested to learn that this subject is under discussion in the *Academy**. There is also an interesting correspondence to be found in "KNOWLEDGE" †.

Yours, etc.,

GEO. PHILLIPS.

26, Mount Stuart Square, Cardiff,
February 20, 1910.

Galileo and Heresy.

SIRS,—In your issue for January the Rev. J. W. Brady states that "it is a threadbare fact of history that Galileo was never accused of heresy." Is this so? I have a translation of the sentence of the Inquisitors General before me, in which the following terms occur: (*a*) The inquisitors style themselves "special deputies against heretical depravity." (*b*) The proposition that the sun is in the centre of the world and immovable from its place is absurd, philosophically false, and formally heretical. (*c*) The proposition that the earth . . . moves and also with a diurnal motion is also absurd, philosophically false, and, theologically considered, equally erroneous in faith. (*d*) Invoking, therefore, the most holy name of our Lord Jesus Christ . . . we pronounce, judge, and declare that you, the said Galileo, by reason of these things . . . have rendered yourself vehemently suspected, by this Holy Office of heresy, that is to say, that you believe and hold the false doctrine . . . namely, that the sun is the centre of the world and that it does not move from east to west, etc. The whole text will be found in Mitchell's Orbs, 1854, and I cannot believe it to be false. I hope the Rev. J. W. Brady or some other correspondent can assist us to facts, if Mitchell is wrong.

Yours, etc.,

January 28, 1910. TRIA.

Astronomical Superstitions.

SIRS,—If the discussion on the article entitled "Astronomical Superstitions" in the December number of "KNOWLEDGE" is not closed, I beg your permission to add a few words of sympathy with the writers of the letters in your January number, not, indeed, with all their incidental expressions of opinion, but with their general feeling of indignation against the article in question, savouring, as it does, of coarse materialism, and something very like intolerant atheism.

Indeed, the author appears to consider religion and superstition as much the same thing; and the whole drift of the article seems to be an attack on revealed religion, with little or no contribution to scientific discovery. It does, however, imply that the old system of astronomy with the earth as physical centre was partly the result of human folly and pride which encouraged man to think he was the one object for which everything else was created—as if such a philosopher as Ptolemy were likely to be biassed by such a motive. The old geocentric theory was by no means unreasonable before the invention of the telescope; but when this all important instrument was turned upon the heavens, the old system was doomed, and it very slowly but surely was overthrown.

And even now it is not an improbable opinion that the earth, as the abode of man, may in some sense be the moral centre of the universe, though physically far otherwise; if the writer of this article had read Dr. Alfred Wallace's interesting work on Man's Place in the Universe he would have seen this idea elaborately worked out. I pass by one or two other points, not wishing to trespass on your space; and I refrain from dealing with the question of Galileo, having said elsewhere what I venture to think on that much vexed subject—merely remarking that many of those who do discuss it show that they do not know much of the facts of the case. In conclusion let me say that while I do not mean that every scientific theory which appears to contradict some theological opinion—possibly an unfounded or mistaken one—should therefore be treated as forbidden matter; yet I do respectfully submit for your consideration that a scientific periodical might well refrain from printing offensive attacks on Christianity, or any other religion held at least by persons who are members of civilised society.

Yours, etc.,

F. R. WEGG-PROSSER.

Merry Hill House,
Belmont, Hereford.

* See *Academy*, Nov. 20 and Dec. 25, 1909; also Jan. 1, 22, and 29, and Feb. 15, 1910.

† See "KNOWLEDGE," Feb. 1, Sept. 1, Oct. 1, and Nov. 1, 1900.

NOTES.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S., F.R.A.S.

HALLEY'S COMET.—This has slowly increased in brightness during the past month, but owing to the continued recession of the earth in its orbital motion the comet is still only telescopic. It is reported to have been seen with a pair of field-glasses after being located with a telescope, and Senor Raurich, of Barcelona, has obtained several photographs showing the comet with an ordinary camera having a lens of 1 inch aperture and 6 inches focal length. At the last meeting of the Royal Astronomical Society a photograph was exhibited showing the comet as photographed with the powerful 30-inch reflector at Greenwich Observatory, exposure about an hour. A distinct tail was visible, and the nebulosity round the head appeared to be decidedly elliptical, with the longer axis almost at right angles to the direction of the tail. It is rather unfortunate that just as there is a possibility of the comet becoming bright enough for general observation it will pass into conjunction with the sun, and will be lost to view for about a month. Given clear skies, however, it may be possible to follow it to about the middle of March, and the following positions are given as a guide in picking it up in the western sky just after sunset.

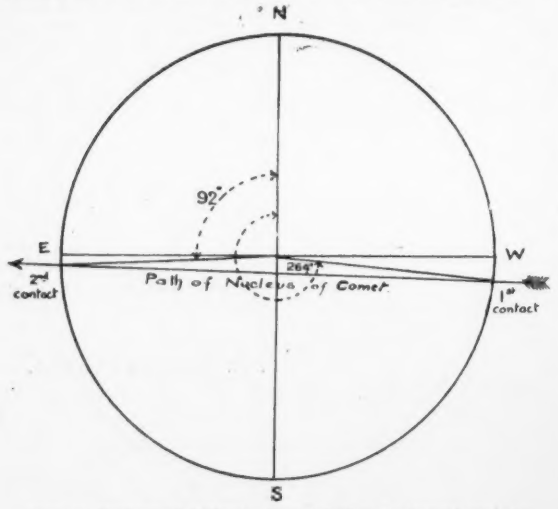
	R.A.	Decl.
1910. Mar. 1.1 ..	0h 33m 59s	+ 7° 55′
,, 6.1 ..	0 30 8	7 57
,, 11.1 ..	0 26 23	8 0
,, 16.1 ..	0 22 34	8 2
,, 21.1 ..	0 18 30	8 4
,, 26.1 ..	0 14 12	8 5
,, 31.1 ..	0 9 38	+ 8 4

Although observers in Europe will not be favoured with a chance of seeing the transit across the sun on May 18, it is hoped that those resident in Asia, Australia, and the Pacific Islands will endeavour to do whatever is possible in recording any phenomena connected with it. From Mr. C. J. Merfield's new elements Mr. A. C. D. Crommelin has re-calculated the particulars of the transit as follows:—

XUM

Transit of Halley's Comet over the Sun
1910, May 18.

First Contact, May 18d 14h 22m G.M.T. at position angle 264°.
Least distance of centres, May 18d 14h 52m G.M.T., comet 62″ S.
Last Contact, May 18d 15h 22m G.M.T., at position angle 92°.
Horizontal Parallax of Comet =54″·4, =45″·7 relative to Sun.



Path of Nucleus of Halley's Comet during its transit over the Sun's disc, 1910, May 18.

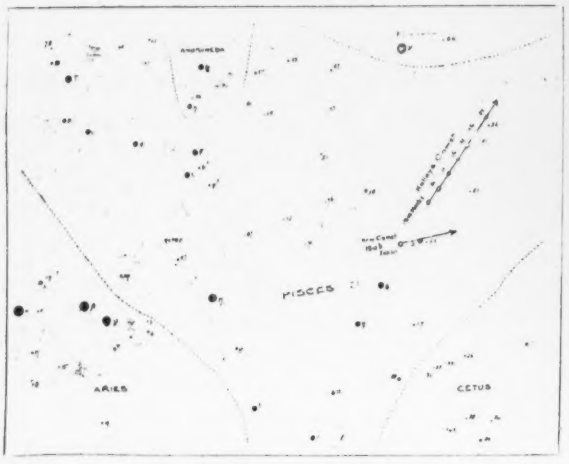
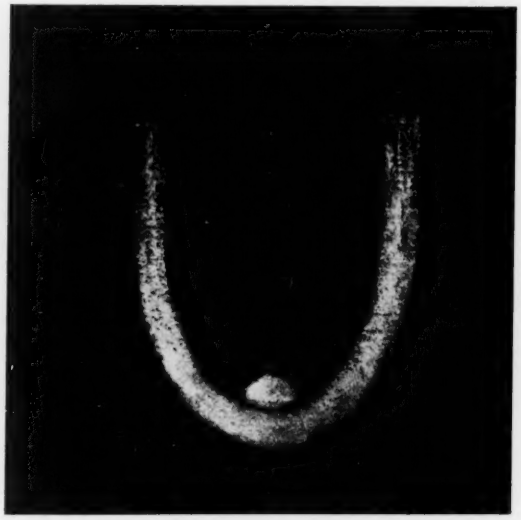


Chart showing path of Halley's Comet during March, 1910. Also position of New Comet 1910b at discovery and projected path afterwards.

It is hoped that observers with any spectroscopic equipment will endeavour to record any phenomena connected with absorption of the solar light by the nucleus of the comet as it passes over the sun. It seems likely that the spectroheliograph of the Solar Physics Observatory at Kodaikanol, India, will be available for this purpose, and interesting results may be expected from this mode of examination. If the length of the comet's tail be about 15 million miles the earth will pass through it, and observers in this country are specially requested to keep watch for any abnormal atmospheric phenomena during the days May 17, 18, and 19. This is suggested by the fact that when the earth last passed through the tail of a comet, in 1861, very remarkable glows were seen in the sky, although it was not known until some time afterwards that they were due to the minute particles of cometary matter intermingled with our atmosphere. Should the tail be considerably longer than 15 million miles, it may be possible to see it projected on the sky directly opposite the sun.

Messrs. Frost and Parkhurst have been fortunate enough to secure a spectrogram of the comet at the Yerkes Observatory, and find the light to be concentrated chiefly in the third cyanogen band. This raises an interesting point in connection with the photographic observations, as it is possible that the comet may be more easily obtained with quartz objectives or speculum metal mirrors than with glass objectives, which absorb a great proportion of the ultra-violet light. It will be remembered that Comet Morehouse also exhibited this peculiarity of being specially rich in violet radiation, being thus much brighter as photographed than when observed visually.

COMET 1910a.—This comet has been very widely observed during the past month, and has probably equalled in general interest the last prominent naked-eye comet of 1882. Numerous photographs of it have been obtained, but as they were chiefly got with the last remnants of twilight and low down near the horizon they are very difficult to reproduce. Towards the end of January a subsidiary tail was developed branching out from the nucleus on the eastern side and bending over in a sharp curve towards Venus. Very beautiful photographs were obtained by Father Cortie at Stonyhurst, and Mr. Morris at Sutton, showing these features very clearly. The tail was distinctly curved, with the



Drawing of Comet 1910a, observed by C. P. Butler with a 9-inch Cooke Refractor at Sutton, 1910, Feb. 22d, 5h 5m G.M.T.

western boundary more sharply defined than the eastern. The dark rift extending from the nucleus is most probably due to the cometary matter being in the form of a hollow cone, produced by the material ejected from the nucleus being repelled away from the sun; this would give the appearance of a double tail owing to the edges of the cone showing of greater brightness when seen tangentially, in the same manner as the gaseous trails of very bright meteors have often been seen to be double.

The spectroscopic observations to hand are somewhat meagre. During the first stages a conspicuous yellow band was observed, and this has been ascribed to sodium, which has been seen in previous comets having small perihelion distances. Mr. Albrecht found by measurement of the sodium bands that the velocity of recession was about 66 km. per second. During the recession from the sun this band was replaced by one in the green, probably indicating the presence of hydrocarbons. As the comet is now rapidly receding from the earth and the sun it is not expected that it will be possible to observe it further during March.

Several drawings have been published showing the nucleus of the comet to be outside the coma towards the sun. This is not in accordance with the majority of observations made with sufficient telescopic power, and is contrary to what has been observed in the structure of former comets. As observed with a medium power on a 9-inch refractor on January 22 the nucleus was most dis-

XUM

tinctly on the extreme inner edge of the head of the coma, with the most brilliant parts of the tail showing as the long antennæ continued from the envelope stretching away from the sun. This point is of great importance in the investigation of the cause of cometary ejection. The nucleus was oval in shape, of quite definite outline, and bright golden in colour. The envelope and tail were also of yellowish tint, but as the comet was low down in the western sky it is possible part of this was due to atmospheric absorption.

PHYSICAL FEATURES OF MARS.—Considerable interest has been aroused in this question of the markings on the planet Mars by the superb photographs obtained at Mount Wilson with the 60-inch reflector and also by the important pronouncement of M. E. M. Antoniadi of the results of his observations with the 32-inch refractor at Meudon, near Paris. He finds that there is an objective reality underlying the series of dark streaks observed by Schiaparelli at Milan, and has repeatedly witnessed the steady visibility of groups of complex irregular shadings in the exact positions of the so-called "canals." This is not considered, however, to be in favour of the reality of the complicated geometrical network presented by the Flagstaff observers, and three definite objections are given for his adverse view. (1) The unnaturalness of the appearance of the straight lines, which are so different to the general delicate blur enveloping the other well-known and accepted markings on the planet. (2) Some of the Flagstaff drawings show straight thread-like markings near the limb of the planet. It is evident that if a canal were to appear straight when on the central meridian it could not appear anything other than curved when the rotation of the planet carried it near the limb, so that if all the canals are of similar nature, as is claimed, this failure to obey the laws of prospective is a serious objection to their reality. (3) Under conditions when numerous complex markings were clearly visible at Meudon, absolutely no trace of the fine linear canals could be discerned. Professor Barnard's valuable opinion is quoted to prove that for such delineation of detail large telescopes are much preferable to small ones. The full aperture of the Henry refractor, 32.7 inches, has invariably been used at Meudon, and this gives a ratio of 5 : 2 compared with the 24-inch Flagstaff with its aperture stopped down to 15 inches. Great care was taken in utilising the times of best definition in the investigation, and the fact of the admittedly splendid definition on the Arizona tableland is not lost sight of in the conclusion.

Professor Lowell responds to this criticism by emphasising the fact that clear definition of ultimate detail depends on the unbroken character of the diffraction pattern of the telescopic image, and that the detail stated to be seen by the large telescopes and not seen at Flagstaff is probably the confused, broken up pattern of the actual features due to the atmospheric disturbances of the various localities. He lays great stress on the tests, made by Hartmann's very rigid method, of various refractors; so far as he has gone the Flagstaff refractor has given decidedly the best evidence of perfection so far as optical testing goes. As a small item of quite impartial record, it may be stated that the writer of these notes had the pleasure of observing Mars at the last opposition in September, 1909, in the company of Professor Lowell at Flagstaff. The night was not considered to be quite first-class, but the amount of stopping down required to give best definition was not excessive; it was found that independent drawings made by the writer and Professor Lowell agreed very well for all the main features, and also for several of the canaliform markings. What was seen was held quite steadily, and, what is more important, was seen the same during repeated observations separated by intervals occupied by the other observer.

Mr. R. G. Aitken, of the Lick Observatory, suggests that in view of the wide divergence of the views of authorities on this matter it might be advantageous to arrange for a series of observations of Mars to be made by the same observers, with the same instrument at the same locality. This could be met if Professor Barnard, Professor W. H. Pickering, M. E. M. Antoniadi, and Professor Lowell could be brought together at Flagstaff to observe with the 24-inch refractor in what is admitted to be the finest site for astronomical observation in the world.

Jan. 29, 1910. Exposed from 6h. 2m. to 6h. 16m.

Jan. 30, 1910. Exposed from 6h. 8m. to 6h. 16m.

Photographs of Comet 1910a obtained at Sutton, by Mr. Percy Morris, F.R.A.S., with a 3½ lens of 19 inches focal length.

DISCOVERY OF A NEW COMET (1910b).—In a telegram from the Centralstelle at Kiel it is announced that a new comet has been discovered by M. Pidoux at Geneva on February 20. Its position was quite close to Halley's Comet at the time of discovery and the two objects are running in somewhat similar paths. The co-ordinates of the observed position were as follows :—

R.A. = 0h 46m 22 15s
Decl. = + 7° 50′ 41″
1910, February 20d 7h 10·0m Geneva Mean Time.

As observed after discovery the comet was moving fairly rapidly in a south-westerly direction through the middle of the constellation Pisces. Its close proximity to Halley's Comet is indicated on the accompanying chart.

XUM

BOTANY.

By G. MASSEE.

INFLUENCE OF ARIDITY ON THE EVOLUTION OF PLANTS.—Dr. MacDougal, writing in *Plant World*, considers that water is the most important external factor in influencing the evolution of plant life. Upon this factor the development of the gametophytic stage mainly depended. During the extension of plants on dry land, when extensive arid regions were encountered, their influence led to the gradual development of the sporophyte with its vascular, conducting system, and finally to the formation of seeds. It is pointed out that in arid regions from the earlier geological formations, fossil plants are absent, on account of the predominance of plants with separate gametophytes. Cycads and Bennettites were the first plants to develop xerophytic structures, and from these the desert forms may be traced. Aridity is responsible for a general reduction of the surface area, resulting in the production of spines, etc., whereas in extremely arid regions the evolutionary tendency has resulted in the formation of remarkable storage structures in leaves and stems. Such succulent xerophytes represent the highest degree of differentiation in seed-bearing plants, and all such are characteristic of very dry regions throughout the world.

BOTANY OF CHRISTMAS ISLAND.—An account of a botanical excursion to Christmas Island is given by H. N. Ridley, F.R.S., in the *Straits Branch, Royal Asiatic Journal*. After dealing with the flora generally, the author discusses the dissemination of plants. Christmas Island is considered as a true Oceanic Island, that is to say, it has never at any time been connected with the mainland of Java, or with any other land. It is the site of an extinct volcano covered with coral reefs of various ages from the eocene period to the present day. It is probable that some part of the island was above water and capable of maintaining terrestrial plants in miocene times. This being so, it follows that the indigenous plants reached the island by means which enabled them to cross the sea either by their seeds being drifted by sea-currents, or blown there by wind, or carried by birds and bats. The methods by which seeds or fruits can be disseminated are as follows:—(1) Sea borne; (2) bird or bat borne; the seeds having been swallowed and eventually deposited uninjured; (3) adhesive; the seeds or fruit being attached to fur or feathers; (4) plumed seed; (5) winged seed or fruit; (6) powder seed; these last three being conveyed by gales of wind. In addition, there are plants dispersed accidentally or intentionally by man.

In addition to the above ways of colonising new ground, exceptional and unusual methods must be taken into calculation. The author observed an orchid (*Dendrobium crumentatum*) floating apparently uninjured by sea-water in the Banka Strait, far from land. A clump of sugar cane drifted up upon Cocos Island, where it began to grow and was eventually propagated.

ALTERNATION OF GENERATIONS AND OF SEXUALITY IN DICTYOTA DICHOTOMA.—Dr. W. T. Hoyt has described in *Bot. Magazine*, his success in cultivating plants of this interesting seaweed, which possesses two forms of thallus, one producing only asexual reproductive bodies, or tetraspores; the other only sexual bodies, or oospores. Plants of both kinds were placed in separate jars containing seawater in which oyster shells were placed. After the tetraspores in one jar, and the eggs and spermatozoids in the other jar had been liberated, the parent plants were removed. After about two weeks, when the young plants had reached a height of about 1.5—2 mm., the oyster shells bearing them were removed and suspended between posts in the sea. After about two months, on the day when the general liberation of the sexual cells occurred, the shells were brought to the laboratory and examined. The results were as follows: Plants of *Dictyota dichotoma* raised from fertilised eggs gave 55 tetrasporic plants and no sexual ones. Plants raised from tetraspores gave 64 sexual plants and no tetrasporic ones. The tetraspores of a single plant produced both male and female plants, in one case in about equal numbers.

KAFIR-BREAD PLANTS.—A small group of plants belonging to the cactus family, known botanically as *Encephalartos*, met with in South Africa are a source of food supply to the natives, furnished by the farinaceous pith within the stem. The stems are buried in the ground and allowed to remain there for several months; the mucilaginous centre is then taken out and dried, and made into cakes like bread. There are about twelve species, met with only in Africa, mostly in the southern parts, with one or two species extending into the tropics. The plants belong to an ancient type of very slow growth.—(G. V. Nash, in *Journ. N. Y. Bot. Garden.*)

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

THEORY OF DISINFECTION.—From a series of experiments carried out by Dr. Reichel to determine the action of phenol, it was found that not only oil, but also coagulated albumin, cholesterin, and the cellular substance of bacteria entered into simple solution relationships with that disinfectant. Hence it is unnecessary to assume the existence of deep-seated chemical reactions. The activity of solutions of phenol over long periods also appears to depend upon conditions of distribution brought about by physico-chemical means. The death of the bacterial cell must therefore be attributed to the attainment of a certain degree of concentration of the phenol solution in the phase consisting of the bacterial cell substance. Alterations in the disinfectant activity in a short time in solutions containing a small proportion of sodium chloride are probably due to an acceleration of the diffusion caused by the salt; and the influence of temperature upon the disinfectant activity of phenol may also be attributed to its accelerating the diffusion. It is also probable that an abstraction of the water necessary to life may be one of the factors in the disinfectant action of phenol and phenolic substances.

PURIFICATION OF WATER BY HYPOCHLORITES.—A solution of a hypochlorite such as "chloride of lime" or sodium hypochlorite obtained by the electrolytic decomposition of water may be used to destroy bacteria in water. Experiments with these substances were tried upon a large scale in Jersey City, where the water has been treated constantly since December, 1908, with bleaching powder in proportion sufficient to yield 0.03 grain of available chlorine per galion.

Bacterioscopic examination of the water from day to day during the first month showed that the average number of bacteria in one c.c. of the water had been reduced from 559 to 2.7, while no trace of the hypochlorite was left. It was also proved that this proportion of hypochlorite effectually destroyed all micro-organisms of the *Bacillus coli* type, so that the water was rendered safe, as regards bacteria, at a relatively small cost. Filtration was still required to free the water from its natural opalescence.

GAS FOR AERONAUTICAL PURPOSES.—A process of obtaining a gas rich in hydrogen and suitable for filling balloons has recently been described by Herr J. Neurdenburg. It is essentially a modification of the method devised by Rincker and Wolter for the production of an illuminating gas. A bed of coke is blown for a few minutes in a gas producer, and then sprayed for 2 or 3 minutes with a mixture of petroleum oil and water-gas tar, after which the coke bed is again blown with air or steam to expel the gases, and is finally cleaned from any deposited carbon by blowing with steam. In the modified process the reaction is carried out at a higher temperature and the blowing with steam is omitted. The resulting gas contains about 73 per cent. of hydrogen, and 12 per cent. of carbon monoxide, as compared with about 46 per cent. of hydrogen and 31 per cent. of carbon monoxide in the gas produced by the original method; and 47 per cent. of hydrogen and 9 per cent. of carbon monoxide in ordinary coal gas. On the other hand, it is poor in the illuminating hydrocarbons, whereas the oil-tar gas obtained by the older method more closely resembles coal gas in this respect.

XUM

SUBSTITUTES FOR WHITE LEAD.—Owing to the dangers attending the use of white lead pigments for painting interiors, a committee was appointed by the Municipality of Milan to examine various substitutes used in place of white lead. After a year's comparative experiments the committee has published the following conclusions: (1) The stability of coatings produced with white lead and with two kinds of zinc white were practically equal, but the covering power of white lead was better than that of the other pigments; (2) the samples of lithopone tested were perfectly satisfactory five months after their application, but the time was insufficient to draw any conclusions as to their permanency; (3) in the opinion of the committee the favourable results obtained with these substitutes for white lead justify the exclusion of the latter, and they recommend that the Municipality of Milan should prohibit the employment of white lead pigments for indoor painting.

A NEW CHLORIDE OF PHOSPHORUS.—MM. Besson and Fournier record in the *Comptes Rendus* the discovery of a new chloride of phosphorus, P_2Cl_4, which is produced by subjecting a mixture of hydrogen and phosphorus trichloride vapour to the action of a silent electric discharge. The new chloride is an oily colourless liquid, with a pronounced odour of phosphorus. Its melting point is $-28°$ C., and it boils under the ordinary atmospheric pressure at about 180° C. When exposed to the air it gives off fumes, and becomes oxidised, and may, under certain conditions, take fire spontaneously. It gradually decomposes, even when kept in a vacuum, into phosphorus trichloride and yellow compounds varying in composition. The corresponding phosphorus bromide, P_2Br_4, could not be obtained by the same method.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

MEGALOSAURUS FROM THE GREAT OOLITE.—A paper on a skull of *Megalosaurus* from the Great Oolite of Minchinhampton was read on January 26 by Dr. A. Smith Woodward at a meeting of the Geological Society. The specimen was discovered and prepared by Mr. F. Lewis Bradley, F.G.S., and shows for the first time the skull of *Megalosaurus*. It agrees closely with the Megalosaurian skulls of other genera already discovered in the Jurassic and Cretaceous of North America, and resembles *Ceratosaurus* in possessing a bony horn-core on the nose. As in the jaws of *Megalosaurus* previously known, the premaxilla of the new specimen bears four teeth; but these teeth are so different from those of the typical *M. bucklandi* of the same horizon, that they prove the Minchinhampton fossil to belong to a distinct species. The serrations of all the teeth, except those in the front part of the jaw, appear to resemble those of the teeth in *M. bucklandi*. Dr. Woodward was not able to say definitely that the teeth were in distinct sockets, but thought appearances suggested that this was the case. He had noticed thick Megalosaurian teeth, much resembling those of the new fossil, among the isolated specimens from the Wealden.

PLEISTOCENE CAVE-FAUNA.—As a result of systematic investigation of a cave at Warton Crag, in West Lancashire, in 1909, Mr. J. W. Jackson, F.G.S., presented a paper at the same meeting on the vertebrate fauna of the cave. The cave, known as Dog Holes, is situated on the western side of Warton Crag, and opens on a sloping "pavement" of limestone. It owes its origin to the erosion of a series of master-joints in the Carboniferous Limestone. The present entrance to the cave is by a vertical drop from the general level of the "pavement." This entrance is undoubtedly of secondary origin, and is due to the falling-in of the weakened roof of one of the passages. The specimens were derived from the cave-earth below the surface-soil in one of the chambers of the cave. They comprise a large series of small vertebrates, including rodents, insectivores, amphibians, birds, etc. Among the rodents are some interesting forms, the chief of which are the Arctic and Norwegian lemmings, and the northern vole. A large series of non-marine Mollusca was found along with these remains, one species being of particular interest, namely, *Pyramidula ruderata*, only known in this country by its fossil remains in Pleistocene deposits. The mode of origin of the remains may have been through a former swallow-hole. In many respects the cave and its contents bear a striking resemblance to the famous Ightham Fissures.

GEOLOGISTS' ASSOCIATION.—The arrangements for the Easter Excursion of the Geologists' Association comprise a visit to North Devon, the excursion extending from March 24 to March 30. An interesting programme will be carried through. Abbotsham Cliffs, with its contoided Upper Culm Measures and plant remains will first be visited. The coast-line from Baggy Point to Santon, in Upper Devonian (Pilton Beds), will follow. Coddin Hill (Lower Culm), with its Wavellite quarry and Venn limestone beds, Lee Bay and the Valley of Rocks, and, finally, Fremington Pill, with junction of Upper Devonian and Lower Culm, will be visited. Here the igneous dyke will be seen, and the "fish-bed" of Instow beach.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

PHENOLOGICAL OBSERVATIONS IN 1909.—Mr. E. Mawley has for many years tabulated and discussed the phenological observations which have been made in various parts of the British Isles under the auspices of the Royal Meteorological Society. In his report for 1909 he stated that the most noteworthy features of the weather of the phenological year ending November as affecting vegetation were the brief but severe frost at the end of December, 1908, several keen frosts in May, the low temperatures and frequent rainfall of the summer, and the continued warm and wet weather in October. During the whole year wild plants came into blossom behind their usual time, the departures from the average being greatest in March and April. Such early spring migrants as the swallow, cuckoo, and nightingale made their appearance rather earlier than usual. The only deficient farm crops were beans, peas, and hay. On the other hand the yield of wheat, barley, oats, turnips, mangolds, and potatoes was well above the average, and more particularly barley and turnips. The crop of apples, peas, and plums was under average, whereas that of raspberries, gooseberries, currants, and strawberries taken together was fairly good. As regards the farm crops, this was the fourth year in succession in which the yield has been above average.

THE NORTH ATLANTIC ANTICYCLONE.—Colonel H. E. Rawson has examined the "Synchronous Weather Charts of the North Atlantic," published by the Meteorological Office for the months of September, 1882, to August, 1883, and has made an analysis of the tracks of the centres of high pressure areas during that period. He communicated the results in a paper which he read at the last meeting of the Royal Meteorological Society. He found that it is very rare for an individual system, which has traversed the American continent, to cross the ocean from land to land. In every month centres of high areas which have drifted across America and have travelled out on to the ocean are found coalescing there with one another, or with the centre of the persistent anticyclonic anticyclone. From April to July systems cannot be traced crossing the Atlantic and moving eastwards into Europe, nor do those which form over the ocean leave it and pass away eastwards. From mid-February to mid-September, the charts indicate that on arrival on our coasts systems extend westwards, and their centres reverse their easterly movement and drift to the west. In June and July centres of high areas form over the ocean, within the Atlantic cyclone, rather than drift into it from the American continent. From May to August all but one of the eight systems which can be traced drifting into the Atlantic leave the coast near to, or to the north of, Nova Scotia. March differs from all other months in the wide range in latitude which the tracks cover. The seasonal influence is clearly seen in December and January when the tracks are confined to lower latitudes than during the rest of the year.

XUM

FLOODS IN JAMAICA, NOVEMBER, 1909.—Mr. P. R. A. Willoughby, C.E., in a note to "Symons's Meteorological Magazine" on the rainfall of November, 1909, in Jamaica, says: "Fortunately, the floods were confined to the eastern end of the island, the centre of heaviest rainfall being at Hagley Gap, in the Blue Mountains. There 135 inches fell in nine days, and chiefly during the last six. Falls of 108 and 115 inches respectively at Clifton Beach and Radnor are authentic, as a demi-john was substituted for the ordinary receiver. At King's House, Kingston, we had 40 inches in six days, the average year's fall being 36 inches. It has cost my department £25,000 to make good the damage, and many coffee planters suffered severely."

MAGNETIC DISTURBANCES.—Dr. C. Chree, F.R.S., in a paper read before the Royal Society on "Some Magnetic Disturbances at Kew," pointed out that the irregular changes which formed the most obvious features of magnetic storms were accompanied by large, regular, diurnal changes, which were especially striking in the vertical force. In this element the disturbed days in the 11 years 1890 to 1900, gave a regular diurnal inequality, the range of which in the average month of the year was about four times that given by the Astronomer Royal's "quiet" days. The influence of the hour of the day on the character of the disturbance was visible even on casual inspection of the vertical force curves. When disturbances lasting only a few hours occurred in the late afternoon there was almost invariably a rise in the force, whereas when they occurred in the early morning there was a fall.

ORNITHOLOGY.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

THE SHOE-BILLED STORK.—In writing my account of the Shoe-billed Stork in the last issue of "KNOWLEDGE," I discovered, too late, that my friend, Mr. Charles Whymper, in his delightful book on "Egyptian Birds," has given the answers to questions I raised as to the food and flight of this quaint bird.

The bird flies, he tells us, like a heron, with head drawn in close to the body; while in the matter of food it would appear to live principally on that stony-coated fish, the polypterus. The scales of polypterus, as most of my readers probably know, take the form of a very solid mosaic of bony, enamel-coated scales such as obtained among the "ganoid" fishes of Devonian and later periods of the world's history; a few surviving till to-day. The Shoebill obtains most of these fish in places where "short grass [is] flooded with an inch or two of water, inside the fringe of papyrus." The polypterus wanders a good deal into this flooded area. Young birds and small mammals are apparently also eaten when occasion offers, but "shell fish" rarely, or never. Since this armoured-fish seems to form the staple diet it is possible that the peculiar and highly specialised form of the beak has arisen as an adaptation facilitating the capture of such prey.

The carriage of the neck during flight affords another link with the herons.

WHAT IS A "BRITISH" BIRD?—In the *Field* (February 19), the editor, commenting on a letter by Her Grace the Duchess of Bedford protesting against the unintelligent criticism contained in a review of Mr. H. Eliot Howard's "British Warblers," published in an earlier issue of the *Field*, lays it down that since the Siberian chiff-chaff and the greenish willow warbler "do not spend the summer months in this country and rear their young here," we have no right to regard them as British birds. This is a most astounding pronouncement. By this ruling the redwing, great grey shrike, the knot, sanderling, and a score or so more well-known British birds must be removed from the list.

EASTERN PIED WHEATEAR IN SCOTLAND.—In the Annals of Scottish Natural History (January), a most interesting account is given of the occurrence on the Isle of May, in the Firth of Forth, of a female Eastern Pied Wagtail (*Saxicola pleschanka*) on October 19, 1909—the first example of its kind to be obtained in the British Islands.

WATER PIPIT IN DEVON.—Mr. J. B. Nichols, in *British Birds* (February), records the fact that a Water Pipit (*Anthus spipoletta*) was shot so long ago as August 25, 1904, at Brendon, North Devon. In July last it was shown to the late Dr. R. Bowdler Sharpe, at the British Museum, and now, at last, a record thereof has been given to the world.

MONTAGU'S HARRIER IN KENT.—In *British Birds* (February) is a record by Mr. P. Vernon Dodd of a Montagu's Harrier (*Circus cinereaceus*), which was killed on November 18, 1909, near Folkestone. This seems to make but the second time this bird has occurred in Kent in November.

GREENLAND FALCON IN CO. ANTRIM.—Mr. William C. Wright sends a short note to *British Birds* (February), to say that an immature male Greenland Falcon (*Falco candicans*) was captured on December 16, 1909, near Larne, Co. Antrim. This makes the third record for the county.

RED-FOOTED FALCON IN CAMBRIDGESHIRE.—"A fine adult male Red-Footed Falcon (*Falco vespertinus*) was shot in Cambridgeshire in May, 1909," in the close season. This fact Mr. W. Farren communicates to *British Birds* for February.

PHYSICS.

By PROFESSOR A. W. PORTER, B.Sc.

SIMPLE METHOD FOR DETERMINING THE VISCOSITY OF GASES.—The following exceedingly simple method has been devised by Mr. A. O. Rankine: A tube is taken, as shown in the figure. The left-hand limb is a narrow capillary tube about 50 cms. long, while the right limb, in which a pellet of mercury is placed, is wider but still so narrow that the mercury remains intact as it falls; about 3.5 mm. diameter is suitable. The taps at the end are added for convenience in cleaning the apparatus, and for the admission of the gas the viscosity of which is required. The operation consists in bringing the mercury to one end, then quickly inverting the tubes and timing the fall of the rear end of the mercury through a measured distance, from *y* to *z*. This time depends upon the viscosity, because as the mercury falls it displaces the gas from the lower part to the upper part through the capillary. The difference of pressure driving the gas is proportional to the weight of the mercury pellet with a small correction arising from the surface tension of the mercury. It is shown theoretically that if the volume above *y* is equal to the volume *below z* the ordinary formula for finding the viscosity from the flow along a capillary tube will hold good if the length of the pellet is not greater than, say, 5 cms., if the gas is at atmospheric pressure. If the gas is at reduced pressure the pellet must be shorter in proportion in order that the usual formula shall be sufficiently accurate.

The merits of this apparatus, besides its extreme simplicity, are that whenever the vessel is filled, any number of observations may be made on the same gas. Again, the quantity of gas required is very small, so that it is applicable to the rarer gases such as those of the argon group. For determining the temperature variations the apparatus can be readily jacketed with an electrically-heated oil bath. It is suitable for gases at high pressures but not for experiments at low pressures.

The method, in spite of its simplicity, compares favourably as regards accuracy with the very elaborate methods which have been used by various investigators and it should be adopted in every physical laboratory.—(*Roy. Soc. Proc.*, A., Vol. 83.)

NORTH.

The Moon, Part XIa.

Although the 12 parts already published complete all portions of the Moon's surface, this particular portion, contained partly in Part IV. and partly in Part XI., does not show up very clearly, so a separate photograph of this region may be of interest.

XUM

CONDUCTION OF HEAT THROUGH RAREFIED GASES.—An interesting series of measurements have been made by Messrs. F. Soddy and A. J. Berry on the thermal conduction through rarefied gases, the gas in each case being contained in a long cylindrical water-jacketed vessel along the axis of which a narrow platinum strip was stretched. Heat was supplied electrically to this strip to an amount determined by the measured currents and voltage between the ends. This method of electrical heating had been used before by several investigators, including Schleiermacher, Bottomley, and Messrs. Ayrton and Kilgour. The object of this series of experiments was to obtain fuller data for extremely low pressures, such that the actual path of the molecule of the gas is comparable with its mean free path. It was indicated theoretically that for sufficiently low pressures the conductivity should be proportional to the pressure, although for higher pressures it is nearly constant. The experiments indicate that up to pressures of about .03 mm. the proportionality to pressure exists for oxygen, nitrogen, neon, argon, carbon monoxide, carbon dioxide, nitrous oxide, cyanogen, and methane; while for helium a similar proportionality exists up to .08 mm., and for hydrogen up to at least .10 mm. Beyond 1.5 mm. pressure the conductivity did not increase with increasing pressure for any of the gases examined, except helium and hydrogen. The limiting values of the energy dissipated when the strip was at 61° C. are given in the following table:—

Hydrogen	...	8.75	Carbon Monoxide		1.37
Helium	...	7.30	Acetylene	...	1.24
Methane	...	2.81	Argon ...	...	1.07
Neon ...	...	2.35	Cyanogen	...	.97
Oxygen	...	1.55	Nitrous oxide	...	.97
Nitrogen	...	1.44	Carbon dioxide...		.95

—(*Roy. Soc. Proc.*, A., Vol. 83.)

COMPRESSIBILITIES OF HELIUM AND NEON.—Work on the pressure, volume, and temperature relations of the rare gases is very much needed as it is extremely probable that owing to the simple character of their molecules the results will accord better with values deduced from the kinetic theory. Mr. F. P. Burt has recently determined the isothermal compressibilities for helium and neon at 0° C., with scrupulous care. For both gases the values of pressure and volume for pressures from 140 to 800 mm. are found to plot as straight lines against the pressure; the values for neon increasing about one part in a thousand with the pressure through this range, while for helium almost a constant value is obtained as though it were a perfect gas. The former results are much as we would have expected them to be; but the results for the latter gas indicate that the gas theory is still very imperfect. Although it is well known that Van der Waals' equation is by no means in quantitative agreement with the behaviour of gases it has proved very useful qualitatively. Now, for any gas following this equation $p\,v$ should only be constant for small pressures provided that its temperature is 27/8 times its critical temperature. But the above experiments were conducted at more like 50 times the critical, and for such temperatures $p\,v$ should increase with the pressure (as in the case of neon). An equation has been given by Dieterici which can be proved to be a much more satisfactory one for many gases, viz., $p = \frac{RT}{v-b} \exp.\left(\Lambda / (RT^{\frac{3}{2}} v)\right)$; but for all gases for which this is the true equation the constancy $p\,v$ for small pressures would only obtain when the temperature was about $2\frac{1}{2}$ times the critical value; so that the difficulty in this case is greater than before. These new experimental results are therefore of very great value and we must look forward to an extension of them to other temperatures and pressures in order that we may have a secure experimental basis for further extensions of theory. —(*Faraday Society*, January, 1910.)

ZOOLOGY.

By R. LYDEKKER.

AFRICAN FRUIT BATS.—In addition to possessing the great hammer-headed species (*Hypsignathus monstrosus*) of the forests of the west coast, one of the most hideous and repulsive-looking of all bats, equatorial Africa is the home of a group of fruit-eating bats collectively known as epauletted bats. These bats take their name from the circumstance that the males of the majority of the species are furnished with large glandular pouches in the skin of the sides of the neck near the shoulders, from the apertures of which project tufts of long, coarse, yellow hairs. Till recently all these bats have been included by most naturalists in the single genus *Epomophorus*. Anchieta's fruit-bat, *Pterotes anchietæ*, of the Benguela district, has, however, been shown to represent a distinct generic type, which in some degrees serves to connect the more typical kinds with the hammer-headed species and the short-tailed African flying-foxes of the genus *Rousettus*, or *Xantharpyia*. In place, for instance, of having only $\frac{2}{2}$ pairs of cheek-teeth like the typical epauletted bats, it has $\frac{3}{3}$ pairs, and is thus only a step from *Rousettus*, in which the number is $\frac{2}{2}$. In addition to this, it is characterised by the great width of the palate, which exceeds that of all the other members of the group, as well as that of *Rousettus*. The next generic representative of the group is *Epomops*, as represented by *E. franqueti*, *E. comptus*, and *E. buettikoferi*, which agrees with *Epomophorus* in the number of its teeth, but has a broad palate flattened behind, as in *Rousettus*. In marked distinction to this, is the narrow and posteriorly hollowed palate of the typical genus *Epomophorus*. In this respect *Epomops* and *Epomophorus*, both of which feed on soft, ripe fruits, especially figs, have followed essentially different lines of development in adapting themselves to a special kind of diet. The last generic representative of the group is *Micropteropus*, easily recognised by the extreme shortness of its skull, which approximates to that of *Cynopterus*.

In equatorial Africa, the aforesaid groups of fruit-eating bats take the place occupied in Madagascar, the Seychelle and Comoro Islands, and the Indo-Malay countries and Australia by the typical flying-foxes of the genus *Pteropus*, which are as foreign to the African mainland as are cray-fishes. It is, however, very remarkable that a member of the latter genus has recently been ascertained to inhabit Pemba Island, situated within a comparatively few miles of Zanzibar. Why the genus should have got thus far, and yet never reached either Zanzibar or the adjacent mainland is one of those mysteries of geographical distribution which are so difficult of satisfactory explanation. The occurrence of these flying-foxes in Madagascar, the Seychelles, Comoros, and Aldabra in the Mascarene group seems to indicate that these islands were connected, at any rate by means of an archipelago, by way of the Andamans and Nicobars with Ceylon and India long after they were completely isolated from Africa.

YOUNG OF NINE-BANDED ARMADILLO.—Two cases of the breeding of the nine-banded armadillo in captivity in the United States are recorded by Mr. H. H. Lane in the first number of the *Research Bulletin* of Oklahoma University. In both instances the number of young was four; and as the female has two pairs of teats, one pectoral and one inguinal in position, it seems practically certain that four is the normal number of young in this species (*Tatusia novemcincta*), although it has been stated that the number varies from four to ten. The most singular thing about these young was, however, that in both instances all were of the same sex. The same fact was recorded some twenty years ago in the case of another species (*Tatusia hybrida*), which produces six or more young at a birth, by von Ihering. From this fact, coupled with the marked similarity of the young in each litter, and the circumstance that in each case the whole of the young were enclosed in a single chorionic vesicle, it is inferred that the armadillos of this genus are polyembryonic, that is to say, all the members of a litter are the product of a single fertilised egg, owing to the separation of the early germ-elements, or blastomeres.

REACTIONS OF ORGANISMS TO LIGHT.—As the result of a series of researches, Mr. F. Loeb has found that the orientation of animals towards a source of light follows the same laws which determine the heliotropic orientation of plants. It has also been demonstrated that plants show

no, or only weak, heliotropic reactions behind a red screen, while behind a blue screen their heliotropic reactions occur almost as perfectly as in mixed light. Further, Mr. Loeb has shown that the same holds good for animals, since they react but slowly or not at all behind a red screen, while their heliotropic reactions behind a blue screen are almost as distinct and rapid as in mixed light. In a recent paper issued in the physiological publications of the University of California, Messrs. Loeb and Maxwell have demonstrated that similar reactions hold good in the case of both swimming animals and algæ.

PAPERS READ.—At the meeting of the Zoological Society held on February 1, a paper by the Hon. Paul Methuen was communicated on a collection of freshwater crustaceans from the Transvaal. On the same occasion Dr. J. Pearson discussed the holothuzian fauna of the Kerimba and Mergui Archipelagoes; while Dr. G. S. Brady gave a revision of the British representatives of certain groups of the ostracod crustaceans; and Mr. Beddard read a paper on the anatomy of the hippopotamus. At the meeting on the 15th, Mr. R. E. Turner communicated observations on the digging wasps of Australia. Mr. H. H. H. Druce described certain new butterflies from West Africa, and Mr. C. L. Boulenger discoursed on certain fatty structures in toads.

REVIEWS OF BOOKS.

ASTRONOMY.

How to Work with the Spectroscope, by J. Browning, F.R.A.S. (London: John Browning; 1s. 6d. with chart, 9d. without).—This handy little manual has been prepared to help the beginner in spectroscopic analysis. After a short opening notice of the various applications to which the spectroscope is adapted, the practical manipulations of several types of spectroscope are described in detail, full instructions being given how to volatilise the substances under examination, and the numerous precautions necessary in taking the readings and plotting them to obtain the wavelength numbers which permit of the recognition of the substance. A very good plate of representative spectra is reproduced in colours, showing the chief lines in the spectra of the sun, stars, nebulæ, gaseous and metallic elements.

The Story of Eclipses, by G. F. Chambers, F.R.A.S. (London: Hodder and Stoughton; pp. 256; 1s. net).—Prepared as a sequel to the author's "Story of the Solar System" and "Story of the Stars," the present volume will be welcomed by those interested in the series of solar eclipses which are to take place during the next few years. Much of this interest is undoubtedly due to the increased facilities presented for modern travel, enabling one to easily reach regions which were formerly only accessible to specially equipped expeditions. Starting with chapters showing the geometrical conditions necessary for the occurrence of eclipses, the author passes on to describe in detail the chief phenomena accompanying a total solar eclipse—the shadow bands, colours of landscape, Baily's beads, corona, etc. A long series of historical eclipses from classical to modern times then occupy attention, and a catalogue of eclipses as a record. Two short chapters are devoted to eclipses of the moon, and another to hints for intending observers.

History of Astronomy, by G. Forbes, M.A., F.R.S., M.Inst.C.E. (London: Watts and Co., 1909; pp. ix. and 154; cloth, 1s. net).—In a small volume like the present one it is obviously impossible to give a complete account of the historical development of astronomy. Professor Forbes, indeed, makes it clear in his preface that his endeavour has been to give only what is necessary to illustrate the tone and spirit of the workers, with a short account of the new discoveries made and the investigations in progress at various epochs. He divides the first half of his book into two portions, the first tracing the gradual association of the world structure with the idea of geometrical arrangement, culminating with the wonderful chimera of epicycles advocated by Ptolemy and elaborated by Copernicus. The next period he styles the Dynamical period, and here we are introduced to the new views of the cosmogony advocated by Tycho Brahe, Kepler, Galileo, and Newton. The grandeur of the new interpretation was further elucidated by the work of Halley, Euler, Lagrange, and Laplace, the latter leaving us his memorable Nebular Hypothesis. The close of this period was marked by the planetary discoveries of Herschel, Piazzi, Adams, and Le Verrier. Dealing next with the development of astronomical instruments, the evolution of and refinement the modern physical aspect of astronomy has Greenwich Observatory, etc., we are shown how by their use been built up. This last section is exceedingly interesting and it is noticeable that few matters of importance have been omitted from the survey of work done during the latter part of the nineteenth century.

CHEMISTRY.

Forensic Chemistry and Chemical Evidence, by W. Jago, F.I.C., Barrister-at-Law (London: Stevens and Haynes; pp. viii. and 256; 5s. net).—Many are the avenues through which the chemist may pass to encounter the law in the witness-box. Since the day when it became recognised that a medical officer of health did not necessarily possess a knowledge of chemistry the legal work of the chemist has steadily increased, and there are now innumerable cases in which the chemical evidence is the chief deciding factor. The present manual, which is the outcome of the author's lectures on the subject at University College, London, deals with this aspect of the work of the chemist, and will probably be widely used by both sides in future cases. After an introductory chapter upon the nature and range of chemical evidence it proceeds to discuss the special application of such evidence in cases under the Food and Drugs Acts, in criminal work, and in civil actions, and concludes with a chapter upon various legal points that may occur in practice, and an excellent index. The special points upon which stress should be laid both by the prosecution and the defence are clearly outlined, and the notes are illustrated by able analyses of the scientific evidence that was given in well-known cases. The book will be found of the utmost value by every chemist whose work lies in the direction of the law courts, while it also contains much that will interest the layman.

The Proteins, by T. Brailsford Robertson (University of California Publications in Physiology).—This is a reprint in convenient form of a series of five lectures upon the proteins, delivered before the University of California. It makes no pretensions to being an exhaustive treatise, but deals clearly with the chemical structure, and physical properties of the proteins and their compounds, the physico-chemical properties of protein solutions, and the hydrolysis and synthesis of proteins. The possible significance of the structure and properties of these compounds in vital phenomena is discussed, and there is an excellent account given of the recent advances in our knowledge of enzymic action. References are given to previous literature on the subject, but the monograph would have gained greatly in value by the inclusion of a classified bibliography.

NATURAL HISTORY.

Leisure Hours with Nature, by E. P. Larkin (T. Fisher Unwin; pp. xv. and 263, including index; 71 illustrations; 5s.).—Both author and publisher are to be congratulated on this work. The subjects with which it deals are as varied as can be, although the very excellent illustrations are for the most part of birds, their nests and their eggs. If we were to select a chapter or two which are perhaps more pleasing than others, we would mention: In a Hayfield; Flowers in May; Snakes and Their Ways; and the Pageant of the Year. We are glad that the author has a word to say against the unreasoning cruelty of the so-called "game-keeper," and his horrible pole-trap. May every landowner see the advantage of suffusing such knowledge as is contained in this book amongst the minds of those whose life is spent in the country, but who are blind to Nature's ways.

Ruskin Nature Reader, selected and edited by G. R. Bennett, B.Sc. (Lond.) (J. M. Dent and Co.; pp. 180; illustrated; 1s. 6d.).—This reader for intermediate classes includes extracts from the writings of H. W. Bates, W. H. Hudson, Richard Jefferies, and others. The extracts are carefully selected and the book is usefully illustrated. There are two passages from Ruskin, and it is just possible the title may mislead those unfamiliar with the course of readers.

XUM

PHOTOGRAPHY.

The American Annual of Photography for 1910, edited by John A. Tennant (New York: Tennant and Ward; British Agents: Dawbarn and Ward; paper cover, 3s.; cloth, 5s.).—This is apparently the only survivor of the old type of annual which consisted chiefly of gratuitously contributed articles and pictures, with a collection of tables, and advertisements. In this volume the tables occupy but a small space, the advertisement pages are about 50, and the remainder of over 300 pages is filled with the articles and illustrations which are very numerous. The English reader will be pleased to find in the list of contributors many well-known names, both English and foreign. Whatever his tastes with regard to photographs he will discover pleasing examples and also examples of what he strives to avoid. The frontispiece is a print on "Royal Velox redeveloped and waxed," and of a rich brown colour. The amateur will be certain to find matters of interest and profit in its pages, but it is impossible to indicate the subjects dealt with without reproducing the table of contents.

MICROSCOPY.

Aids to Microscopic Diagnosis, by E. Blake-Knox, B.A., M.D., etc. (London; Baillière, Tindall, and Cox; Cloth $6\frac{5}{8}$ by $4\frac{1}{4}$; pp. viii. and 156; 2s. 6d. net).—This little volume is one of the well-known "Students' Aids Series," a lengthy list of books designed to aid medical students in their examinations by summarising the salient facts that they have read in larger text-books or met with in their laboratory or hospital work. Several of the volumes are deservedly popular with students for this purpose, but it is a little difficult to say what precise part of the medical curriculum this particular volume is designed to fill. It is primarily a collection of notes from many sources on bacteriology and parasitology as far as they are concerned with the microscope, but bacteriology at least is already dealt with in the series. Blood examination is not treated in this volume except as regards its examination for bacteria and parasites. The portion dealing with tropical diseases is fairly complete, and makes an interesting and convenient summary, but the book endeavours to give also brief notes on the etiology, pathology, and even clinical symptoms of many of the diseases mentioned as due to bacteria and parasites, and these suffer from the necessary condensation, whilst as a laboratory hand-book the volume is handicapped in the same way. The explanation given of the method of estimating opsonic indices is a fair example of this. None the less, the book has packed into it a great amount of information for its size, and is an interesting addition to the series.

MISCELLANEOUS.

Progressive Redemption, by the Rev. Holden E. Sampson (Rebman; pp. 616; 12s. 6d. net).—In an earlier work, "Progressive Creation," Mr. Sampson has endeavoured to relate the beliefs of religion with the discoveries of science. In "Progressive Redemption" his task is the not less congenial one, but from one point of view the simpler one, of tracing the connection between mysticism and the ancient mysteries and religion itself; and by religion he implies not creed but belief. There is a double difficulty in the task. The first part of it lies in the circumstance that mysticism has its own vocabulary and terminology, and that a comprehension of them is necessary for the unravelling of the author's argument. The second part of the difficulty is that the study of mystic symbols and symbolism is itself a science of considerable complexity. The meanings of the sign of the cross; of the swastika; of the sacred tau; the crux ansata—to name but a few—are themselves susceptible of various definitions, and have been subject, like the symbols themselves, to evolutionary changes. It is therefore a little rash to assume, as Mr. Sampson does, that their meaning can be taken for granted, and can be related merely and solely to the mysteries and implications of Biblical teaching. None the less, the author's intention and purpose are explicit and sincere; and his attempt to bring the ancient teachings, the ancient ritual, and the progressive life of the world into unity must command respect.

Wanderings Among South Sea Savages, by H. Wilfrid Walker, F.R.G.S. (London: Witherby and Co.; pp. 254, including index; 7s. 6d. net).—This work is well illustrated with 48 plates from photographs, and is of great interest. The author states that it does not pretend to be scientific, being for the most part comprised of letters written home by himself, whether in Dayak or Negrito huts, or in the lonely depths of tropical forests. Being a naturalist, the author might well, perhaps, have given some further account of the specimens which he skinned or bottled. As it is, we have to be content with references here and there to the wild life of the parts visited. The description of the bird-caves of Borneo is valuable, and perhaps more so is that of the author's visit to the flat-footed lake-dwellers, the Agai Ambu, of New Guinea. He states that it is an exaggeration to describe these people as having "webbed" feet, although he says there is "between the toes an epidermal growth more distinct than in the case of other peoples." Their feet were broad, short, and very flat.

Aerial Navigation of To-Day, by Charles C. Turner (London: Seely and Co., 1910; 5s. net).—There are indications that the dearth of serious modern works dealing with aerial navigation—not solely written for the consumption of the expert—is coming to an end. These indications, of which Mr. Turner's book supplies not the least important, are doubly welcome in that they go to show, firstly, that the public takes a deep, almost insatiable, interest in this latest born of sciences, and, in the second place, that it is recognised—although as yet imperfectly—that the subject is eminently one that has everything to gain from public interest. It will, of course, scarcely be disputed that the most difficult task that can fall to the lot of a writer is to write a book expounding a branch of scientific knowledge, and especially one that is new, in a manner that shall be at once popular and do justice to the scientific and technical requirements of his subject. It must be admitted that Mr. Turner has succeeded very well in this difficult task. The inevitable historical chapters that form an introduction to the present work—and let us confess at once that these constitute one of the most reliable and readable histories of this thorny subject that have yet come to our knowledge—are followed by a sound explanation of the principles of aerostation and of aviation, the "lighter" and "heavier-than-air." Here there is, however, one passage in which the author does himself less than justice. His explanation of the flight of birds is too brief and woefully inadequate. In the first place, "soaring flight, instead of being *often* achieved against the wind," is, of course, *always* accomplished in the teeth of the wind, however slight the latter. Then, in attempting to solve the problem of "flapping-wing" flight, why drag in that antique and exploded theory of the "partial vacuum above the wing," or, again, why confine lifting-power to the downstroke and propulsion to the up-stroke? Whatever theory one may hold of the action of a bird's wing, it is surely self-evident that its upward and downward motion each produces—although, possibly, in unequal degrees—both lift and propulsion. This, however, is but a minor defect in an otherwise excellent and reliable summary. In subsequent chapters the author carefully analyses the possibilities of the various modes of aerial navigation. His chapter on the "Aerial Ocean" is a particularly happy feature, though in his enumeration of low temperatures he omits to mention the lowest natural temperature ever recorded (−111° Fahr.), registered at a comparatively feeble height by an instrument sent up from St. Louis by Professor Rotch. There follow discussions of most of the aspects of aeronautical development—its effect on transport, exploration, warfare, law, society—which are always conscientious, while the conclusions arrived at can usually be endorsed. The book further contains a number of useful tables, a glossary of English technical terms with their French equivalents, a brief bibliography and an excellent index. The photographs and diagrams are uniformly good and have been carefully chosen with due regard for the requirements of the text. On the whole the work may be recommended to every student of this fascinating branch of human activity as being thoroughly reliable, conscientious, and—not least—up-to-date.

XUM

MICROSCOPY.

Conducted by F. SHILLINGTON SCALES, M.A., F.R.M.S.

High Power Dark Ground Illumination.

WITHIN the last few years the method of the so-called dark ground illumination for high magnifications has excited considerable interest and, accordingly, several of the most reputable makers of microscopes have devised various forms of condensers for observation in a dark field. The fundamental principle of the method of observation in a dark field is the modification of the incident pencil in such a way as to establish a marked contrast between intensely illuminated particles, such as living bacteria, and their dark surroundings.

The finer the detail under observation, so in a measure must the intensity of the illumination be increased so that the particles may emit an amount of diffused light sufficient to enable them to be observed.

Reflecting condensers, and other appliances designed for the same purpose, may be regarded as objectives which form an image of the source of light in the plane of the object under observation, but solely through the instrumentality of rays which are prevented from passing directly into the microscope objective. The observer, therefore, sees diffused light at those points only which are occupied by particles differing optically from the surrounding medium, whereas the remainder of the field remains dark. It may be safely stated that the variety of condensers now made for high power dark ground illumination may be divided into two distinct classes, namely, paraboloidal and spherical. There is another type made which takes the form of a cone, but as its performance is very poor it hardly deserves consideration.

The term Paraboloid is generally used when reference is made to dark ground condensers, no doubt owing to the fact that this form was the first employed and invented by Wenham nearly half a century ago. However, since the spherical forms with their two reflecting surfaces have been introduced, a controversy has been raised, and the point at issue is, which form gives the best results?

As previously stated, the intensity of illumination must be increased the smaller the objects under observation. To realise this requirement the following three conditions have to be fulfilled :—

(1) The difference between the apertures of the inner and outer pencils should be as great as possible.

(2) The image of the source of light formed at the apex of the pencil should be as well defined as possible, *i.e.*, the rays should be brought to a precise focus.

(3) The image should be free from spherical difference of magnification by satisfying the condition of sines.

Chromatic errors are eliminated owing to the image being formed by reflection, not by refraction.

The completeness with which the second and third conditions may be fulfilled increases with the number of reflecting surfaces.

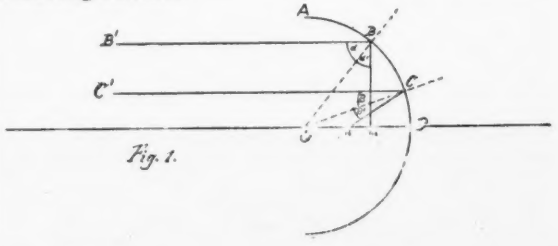


Fig. 1.

Let A B C D E be a spherical reflecting surface, of which O D is the axis and O the centre of curvature. Let B^1 B be an incident ray parallel to the axis O D. This ray is reflected so that the angle B^1 B O = the angle O B *m*, or the angle *d* = the angle d^1. Let the reflected ray inert the axis at *m* and let another ray C^1 C after reflection inert the axis at *n*, then the distance between *m* and *n* is known as the spherical aberration. So long as the surface A B C D E is spherical it is impossible to eliminate spherical aberration. To accomplish this the surface must be paraboloidal. We may, however, retain the spherical surface and yet diminish this aberration by employing two instead of one reflecting surface.

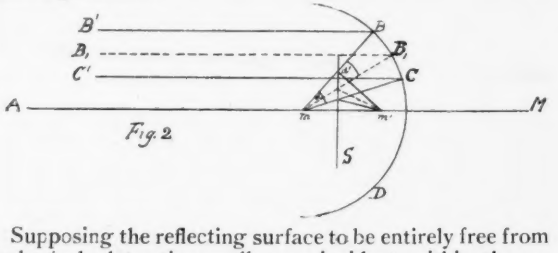


Fig. 2.

Supposing the reflecting surface to be entirely free from spherical aberrations, all rays incident within the extremes B^1 B, C^1 C in a direction parallel to the axis must necessarily meet at a point *m* on the axis A M. The intensity of the light at *m* depends upon the magnitude of the angle B *m* C. One maker interposes a mirror at S so as to transfer the bright point from *m* to m^1. This, however, has the effect of cutting off a portion of the incident pencil of light, which thus becomes reduced to a pencil bounded by the extremes B^1 B and B_1 B_1. Moreover the angle, and, consequently, the effective aperture, becomes reduced, hence the point, or the particles under observation become darker. Apart from spherical aberration there is another source of defect which needs close attention; this defect arises from the non-fulfilment of the condition of sines and is known as the spherical difference of magnification.

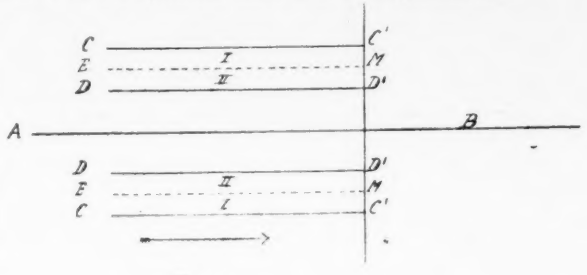
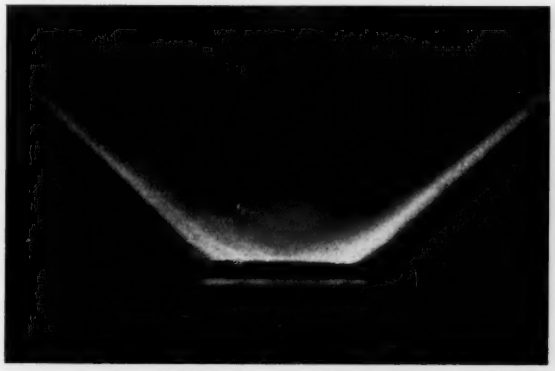


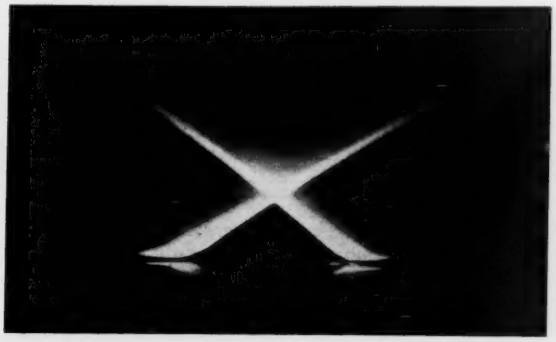
Fig. 3.

Let A B be the axis of the reflecting condenser, C^1 C^1 the lower surface at which the light enters. The inci-

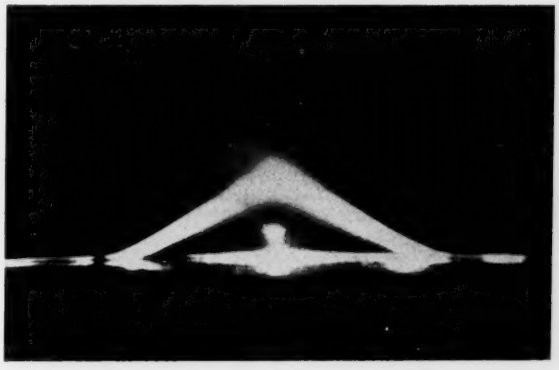
dent light comprises an annular pencil C C^1—D D^1, D D^1 being, as a rule, excluded by a stop to prevent the entrance into the objective of any direct rays. The annular pencil of rays proceeding from a point source of light would, after reflection at the mirror of the microscope, form a point image where the rays inert ing pencils, the quantity of light within I being equal to that within I I. If, now, the cylindrical pencil I be cut off by an annular stop, an image of the source of light will be formed at *m* due to the rays within I I, and conversely if the rays passing through I I be stopped by a ring diaphragm, an image would be found at *m* by



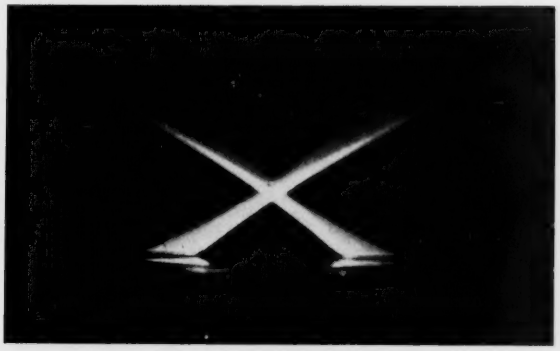
Conoid (Seibert).



Holos Paraboloid (Watson and Sons).

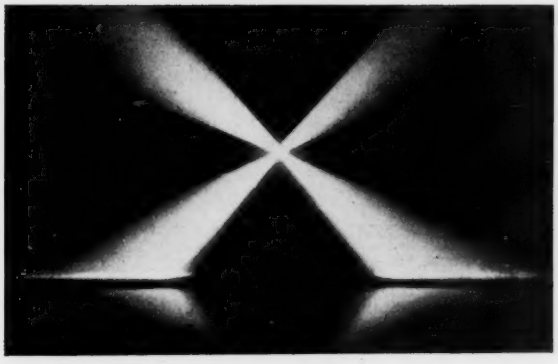


Spherical (Reichert).



Paraboloid (Zeiss).

Dark Ground Illuminator (Beck).



Spherical (Leitz).

[All these photomicrographs have been taken under precisely the same conditions.]

the axis (*e.g.*, at *m* in Fig. 2). As a matter of fact the source of light is never an actual point, however small an area it may occupy, and hence the image has necessarily a superficial extension. Suppose the incident annular pencil, as shown in Fig. 3, bisected a cylindrical surface E M, and let I and I I be the result- the rays passing through I. In either case the image covers a certain, though a small area, and these two images will not be equal unless the condition of sines be satisfied. The equal magnitude of the images has the advantage that either image furnishes an equal amount of light per unit area, and, therefore, illu-

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minates a particle in a similar degree. If the images are dissimilar the larger image produces a less intense illumination, since the light is spread over a larger area.

In the case of the paraboloidal condenser the presence of the parabolic surface renders it impossible to fulfil the condition of sines, which is a drawback, as the defect is very considerable. It is impossible to satisfy this condition when there is only one spherical surface, but when there are two spherical reflecting surfaces the condition of sines may be satisfied to a high degree.

As stated, the dark ground condenser forms an image of the source of light in the plane of the object, *i.e.*, it plays the part of an objective of a definite focal length, therefore it is reasonable to express the degree of the aberrations in the percentage of the focal length. Instead of entering into figures of comparison I append a series of photo-micrographs of the rays issuing from the condensers of various makers.

To obtain the most satisfactory results it is essential that oil immersion apochromatic objectives and compensating eyepieces be employed, especially as this mode of illumination is extremely sensitive to differences of colour, and as the high power dry objectives are affected by the thickness of cover-glasses. Oil immersion objectives being independent, to a great extent, of the variations in the thickness of cover-glasses, have an advantage over high power dry objectives with correction collars; further, the absence of reflections at the surfaces of the cover-glass and front lens of the oil immersion objective aids very materially in obtaining a brighter object in a darker field.

When using oil immersion objectives their numerical aperture must be reduced sufficiently to prevent direct rays from the condenser entering the eye. To obviate internal reflections in apochromatic objectives they have to be accurately fitted with several stops, and this can only be done properly by the maker.

It may be of interest to add that, although all the makers advise the use of a strong source of light, I obtain the most satisfactory results with an oil lamp having an achromatic bull's-eye lens interposed between the lamp and the microscope. This light, provided a well corrected condenser is used, is the most suitable for the observation of objects such as living bacilli, Spirochætæ, etc., up to magnifications of 1,000 or 1,500 diameters. These objects are brightly illuminated and the dark ground is perfectly black, therefore the objects under observation stand out in fine contrast. A strong source of light, such as an arc lamp, is, of course, necessary for taking instantaneous photo-micrographs of living micro-organisms.

J. W. OGILVY, F.R.M.S.

Royal Microscopical Society.

February 16.—Annual Meeting, Sir E. Ray Lankester, President, in the chair. Attention was called to a projection lantern, presented by Mr. J. W. Ogilvy, F.R.M.S., provided with a self-regulating arc lamp of about 3,000 candle-power, and having a neat and convenient arrangement for taking any size slide. Mr. C. F. Rousselet exhibited under a microscope some specimens of a rare species of *Pedalion*, *P. oxyure*, Sernow, which he had found in material collected by Dr. Cunnington and C. Boulenger in the brackish lake Birket Qarun, in the Fargûm Province of Egypt. It would be remembered that the first species of this genus, remarkable amongst all other Rotifera for the possession of six arthropodous limbs, *P. mirum*, was discovered in 1871 by Dr. C. T. Hudson, at Clifton, near Bristol. A second species, *P. fennicum*, was found by Dr. Levander, in Finland, in 1892, and the third species, *P. oxyure*, now exhibited, was found by S. Sernow in 1903 in the Aral Sea. The same species was also found last year by Professor von Daday in material collected in Turkestan, and named by him *P. mucronatum*, which name, therefore, is a synonym, and cannot stand. *P. oxyure* most nearly resembles *P. fennicum*, but differs from it in the fact that the posterior end of the body is drawn out into an elongated projection. The President commented on the interesting nature of this find, his opinion being that *Pedalion* was the most wonderful of all the Rotifers, as having legs and striated muscles to work them, and hairs on them resembling those of Crustacea.

Attention was called to an exhibition of sections of eyes exhibited by Mr. F. W. Watson Baker.

The Report of the Council for the year 1909 was then read by Mr. F. Shillington Scales. Particular attention was called to the proposal to admit women Fellows to the full privileges of the Society, and a resolution was subsequently passed by the meeting altering the Rules in order to give effect to this. The Treasurer's Report and Balance Sheet were read by Mr. W. E. Baxter. The following Fellows were elected as officers and Council of the Society for 1910: *President*—J. Arthur Thomson, M.A., F.R.S.E., Regius Professor of Natural History in the University of Aberdeen. *Vice-Presidents*—Frederick J. Cheshire; A. N. Disney; M.A., B.Sc.; J. W. H. Eyre, M.D., F.R.S. (Edin.); E. J. Spitta, L.R.C.P., M.R.C.S. *Treasurer*—Wynne E. Baxter, J.P., F.G.S., F.R.G.S. *Secretaries*—R. G. Hebb, M.A., M.D., F.R.C.P.; F. Shillington Scales, M.A., M.B., B.C. *Ordinary Members of Council*—F. W. Watson Baker; J. E. Barnard; Edward Heron-Allen, F.L.S., F.Z.S., F.R.Met.S.; C. F. Hill; John Hopkinson; Henry Geo. Plimmer, F.L.S.; Thomas H. Powell; P. E. Radley; Julius Rheinberg; Chas. F. Rousselet; David J. Scourfield; W. Wesché. *Librarian*—Percy E. Radley. *Curators*—Chas. F. Rousselet; F. Shillington Scales, M.A., M.B., B.C. The retiring President then gave the Annual Address, in the course of which he congratulated the Society upon its increased prosperity, and after making appreciative reference to the work of the late Dr. Dallinger, he referred to such work as he thought could be carried out by the Fellows with reference to the action of light upon protoplasm, the differentiation and specific effects of α, β, and γ-rays emanating from radium, and the part actually played by bacteria in the process of digestion. Medical science wanted their assistance in these investigations, which he thought could be, in some directions, better followed up by naturalists than by physiologists. Attention was also called to an organism (*Clathrocystis æruginosa*) found by Henfrey in 1852, in a pond in Kew Gardens, and so named by him, as worthy of their attention.

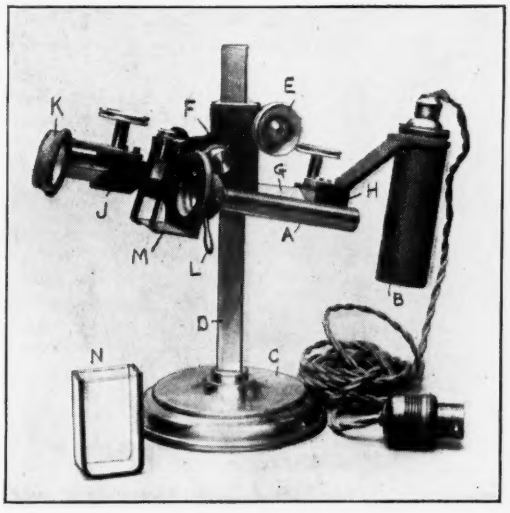
Quekett Microscopical Club.

January 25.—Mr. James Murray, one of the scientific staff on the "Nimrod" in Lieut. Shackleton's Antarctic Expedition, gave an interesting account of the aquatic organisms taken by the Expedition, with especial reference to Rotifers. Four specimens were exhibited. These were *Philodina gregaria*, *P. alata*, *Adineta grandis* (n. sp.), and *Hydatina senta*. The species noted are not very peculiar, the most curious being *Philodina alata*, which has large lateral processes. Much interest attaches to their method of life. The air-temperature in south latitude 77°-78° hardly ever rises above freezing point. This does not favour a great growth

of moss or of the Rotifers which dwell among it. They are usually found in the lakes, which, though frozen for about ten months in the year, attain to a temperature of as much as 60° F. in summer. A series of experiments showed that the species examined were able to withstand greater heating and greater cooling than they ever experience naturally.

Beck-Gordon Speculum Lamp.

The ideal microscope lamp has not yet made its appearance. For really critical work, which requires the source of illumination to be focussed upon the object as carefully as the objective itself is focussed, and for which achromatic and aplanatic condensers are necessary, diffused daylight, though pleasant to work with, is manifestly unsuitable, as there is no source of illumination to focus. With artificial light there is a definite source of light to be dealt with, but it is here that all existing sources of illumination fall short in one way or another. An ordinary half-inch paraffin lamp, set edgeways at about eight or ten inches from the microscope, still provides the best means of illumination, being not too strong to injure the eye-



sight, and yet giving ample light (if properly centred and focussed) for use with even the highest powers, but its light is yellow, and the interposition of deep screens reduces the light too much. The Nernst lamp, as at present made, has too narrow a filament and is of too intense a nature for use visually. The incandescent gas mantle and the incandescent electric bulb give an obtrusive reproduction of the mantle in the one case and of the filament in the other, and, in fact, the incandescent electric lamp is about the most unsatisfactory form of illumination at our disposal.

Mr. J. W. Gordon, without claiming absolute originality, has devised a form of speculum lamp in which the difficulty above-mentioned is overcome by using a glass rod, placed end on to lamp and microscope, so that one end of the glass rod receives light and transmits the same by reflections along the rod to the other end, thus giving a bright, illuminated, but structureless disc, which is used as the source of illumination.

A further advantage lies in the ease with which the intensity of the light can be varied by simply varying the distance between the end of the rod and the lamp. The light is thus readily adjusted for visual work without or with a screen, and without interfering with the adjustment or corrections of the condenser, or alteration in the size of the iris diaphragm.

Mr. Gordon exhibited this form of lamp at the Royal Microscopical Society not long ago, and recently presented a multiple lamp of this nature to the Society. Messrs. R. and J. Beck, Ltd., have now placed it upon the market as illustrated herewith, and a few words of explanation will be all that are necessary.

A is the polished glass cylinder referred to above, and B the lamp opposite one end. At the other end of the glass rod is an iris diaphragm L, a carrier M to take a trough N for monochromatic or other colour screens, and a condenser K. The whole of these are supported on a block F, movable vertically by rack and pinion E, and inclinable about the pivot at F, and the lamp and condenser are each adjustable by rack and pinion J and A, upon the rod G. The whole is carried on a suitable stand and upright C and D.

When the lamp is adjusted close to the end of the glass rod the corresponding disc at the other end becomes most intensely illuminated, but as the lamp is moved away (other adjustments remaining unaltered) the light becomes much reduced, varying as the square of the distance.

The condenser can be swung aside when required, and can be focussed to give parallel light, or convergent light for the illumination of opaque objects.

The iris diaphragm allows of reduction in the size of the illuminated disc, and when closed gives a suitable point of light to focus and centre with for critical illumination.

The drawbacks to the lamp are that the light obtained by its means is not, of course, in the strictest sense critical, and that it is not powerful enough for use with other than visual work, as in photo-micrography. The man who can give us a structureless and immovable disc of light of small size, but of sufficient intensity for this purpose, will confer a boon upon all photo-micrographers.

Notes and Queries.

P. P. W. (*Preston*).—The eggs of butterflies and of other insects are by no means difficult to mount. A disc of dull black varnish of the size of the cover-glass is run on the centre of the slide, and around this a ring of gold-size is run of such a height as to protect the eggs from pressure by the cover-glass. A thin film of gum arabic is placed upon the black back-ground and allowed to nearly dry, the eggs being then placed in position as desired, say, with a fine sable paint brush. The slide is then put aside, protected from dust, and allowed to dry thoroughly. A final ring of gold-size is then put on and allowed to dry until it is just "tacky," when the cover-glass is lowered into position and gently pressed around the edges. A final ring of gold-size over all will make the cover-glass secure. It is of importance to allow the interior of the cell to become thoroughly dry or a fine moisture is apt to settle upon the under surface of the cover-glass. This method of mounting, of course, exhibits the eggs as opaque objects for illumination from above with bull's-eye condenser or side silver reflector, but many insect eggs shrivel up when mounted dry, and it is therefore necessary to mount them as transparent objects in Canada balsam or some preservative fluid. They can be soaked in xylol or turpentine until transparent.

[*Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Redcourt," Adams Road, Cambridge. Correspondents are requested not to send specimens to be named.*]

The Face of the Sky for March.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 6.49 and sets at 5.37; on the 31st he rises at 5.41 and sets at 6.28. The Sun enters the sign of Aries at noon on the 21st, when Spring commences. Sun-spots and faculæ have been fairly numerous of late, and small groups may usually be observed on the Sun's disc; at the time of writing two large spots are visible. The positions of the Sun's axis, centre of disc, and heliographic longitude are given below :—

Date.	Axis inclined from N. point.	Centre of Disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Mar. 2 ..	21° 52'W	7° 14'	1° 58'
,, 12 ..	24° 1'W	7° 12'	230° 12'
,, 22 ..	25° 31'W	6° 57'	98° 23'
Apr. 1 ..	26° 19'W	6° 29'	326° 29'

The Zodiacal light may be seen in the West, shortly after sunset. Early in the month is the best time for observation, as the moon will not have risen, and the tapering glow may be seen for 30 or 40 degrees along the ecliptic.

THE MOON :—

Date.	Phases.	H. M.
Mar. 4 ..	☾ Last Quarter	7 52 a.m.
,, 11 ..	● New Moon	0 12 p.m.
,, 18 ..	☽ First Quarter	3 37 a.m.
,, 25 ..	○ Full Moon	8 21 p.m.

OCCULTATIONS.—The following are the principal occultations visible from Greenwich :—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point. E.	Mean Time.	Angle from N point. E.
			A.M.		A.M.	
Mar. 20	κ Geminorum	3·6	2.29	134°	3.12	250°
,, 29	α Libræ	2·9	3.52	159°	4.51	254°

THE PLANETS.—Mercury (March 1, R.A. $21^h\ 12^m$; Dec. S. 17° 28'. March 31, R.A. $0^h\ 18^m$; Dec. N. 0° 13') is a morning star in Aquarius, rising about 6 a.m. for the first fortnight in the month. The planet is not favourably placed for observation, and towards the end of the month is lost in the Sun's rays as he is approaching superior conjunction with the Sun.

Venus (March 1, R.A. $21^h\ 2^m$; Dec. S. 8° 51'. March 31, R.A. $21^h\ 50^m$; Dec. S. 10° 3') is a brilliant object in the Eastern sky before sunrise, and rises about 4.30 a.m. near the middle of the month. On the 19th the planet is at *greatest brilliancy*, and the telescopic appearance is a crescent with 0·26 of the disc illuminated.

Mars (March 1, R.A. $3^h\ 18^m$; Dec. N. 19° 29'. March 31, R.A. $4^h\ 35^m$; Dec. N. 23° 21') is visible in the evenings, and throughout the month sets shortly after midnight. In consequence of increased distance from the Earth, the apparent diameter of the planet is now only 5″·5, which is too small for useful telescopic observations to be made.

Jupiter (March 1, R.A. $12^h\ 51^m$; Dec. S. 3° 45'. March 31, R.A. $12^h\ 38^m$; Dec. S. 2° 20') is a brilliant object in the evening sky looking South-East. The planet is in opposition to the Sun on the 31st, hence about this date he appears South at midnight. On the 1st the planet rises at 8.30 p.m. and on the 21st at 7 p.m., and is visible throughout the night. The equatorial diameter on the 15th is 43″·3, whilst the polar diameter is 2″·8 smaller; this polar flattening is a conspicuous feature of Jupiter, and is readily observable in small telescopes, also the attendant bright moons and belt markings on the planet's disc form interesting objects of observation. The smallest telescope magnifying about 40 times, shows the planet of the same apparent diameter as the Moon seen with the naked eye, and the surface markings may readily be drawn.

The following table gives the satellite phenomena visible before midnight :—

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
Mar.				Mar.				Mar.			
4	I.	Ec. D.	9 23	13	III.	Sh. E.	10 12	27	I.	Ec. D.	9 32
5	I.	Tr. E.	9 24		III.	Tr. E.	11 35		II.	Sh. I.	11 15
12	I.	Tr. I.	8 55	20	II.	Sh. I.	8 41		II.	Tr. I.	11 26
	I.	Sh. E.	10 44		II.	Tr. I.	9 13		I.	Oc. R.	11 48
	I.	Tr. E.	11 9		I.	Oc. R.	10 5	28	I.	Sh. E.	9 0
13	II.	Sh. E.	8 51		II.	Sh. E.	11 24		I.	Tr. E.	9 3
	III.	Tr. I.	9 30		III.	Sh. I.	11 34	29	II.	Oc. R.	8 48
	II.	Tr. E.	9 37		II	Tr. E.	11 51	31	III.	Ec. R.	7 58

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse and Ec. R. its reappearance.

Saturn (March 1, R.A. $1^h\ 20^m$; Dec. N. 5° 55'. March 31, R.A. $1^h\ 33^m$; Dec. N. 7° 16') is only available for observation for a short time each evening during the month, as he sets at 9.20 p.m. on the first and at 7.41 on the 31st. The planet appears as a fairly bright star looking nearly due West as soon as it is dark. Observed in the telescope, the ring appears wide open as we are looking on the Southern surface at an angle of 13°. The apparent diameter of the outer major and minor axes of the ring are 38″ and 9″ respectively, whilst the diameter of the ball is 15″.

Uranus (March 15, R.A. $19^h\ 45^m$; Dec. S. 21° 43') is visible in the mornings, rising about 4 a.m. near the middle of the month.

Neptune (March 15, R.A. $7^h\ 12^m$; Dec. N. 21° 44') is situated in Gemini, about half a degree South of the star δ Geminorum. Near the middle of the month the planet is on the meridian about 7.40 p.m., and sets about 3.30 a.m. The planet is difficult to identify among the numerous small stars appearing in the same field of view, and as he is practically stationary this month, he cannot readily be detected by his relative motion, moreover, it requires a high power (about 300) and good definition to distinguish his disc.

METEOR SHOWERS :—

Date.	Radiant. R.A.	Radiant. Dec.	Near to	Characteristics.
	h. m.			
Mar. 1-4 ..	11 4	+ 4°	r Leonis	Slow; bright.
,, 14 ..	16 40	+54°	μ Draconis	Swift.
,, 24 ..	10 44	+58°	β Ursæ Maj	Swift.

Minima of Algol occur on the 9th at 9.56 p.m., 12th at 6.45 p.m., and 29th at 11.39 p.m. Its period is $2^d\ 20^h\ 49^m$, by which other minima may be deduced.

Double Stars.—γ Leonis, $X.^h\ 14^m$, N. 20° 22', mags. 2, 4; separation 3″·8. In steady air, the prime requisite for double star observations, this double may be well seen in a 3-in. telescope with an eyepiece magnifying about 30 to the inch of aperture, but on most nights one with a power of 40 is better. The brighter component is of a bright orange tint, whilst the fainter is more yellow.